Final (100%) Groundwater Basis of Design/Design Criteria Report

Volume I

Interim Groundwater Remedy Remedial Design

Standard Chlorine of Delaware Site
New Castle County, Delaware

USEPA Work Assignment No. 038-RDRD-03H6
Black & Veatch Project No. 47118.0131

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1.0 Introduction

The United States Environmental Protection Agency (EPA), under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), has initiated procedures to conduct a Remedial Design (RD) at the Standard Chlorine of Delaware (SCD) Site, New Castle County, DE. This Final (100%) Design Criteria/Basis of Design Report has been prepared by the Tetra Tech/Black & Veatch Joint Venture (JV) under Contract Number 68-S7-3002 with EPA Region III and under specific authorization of EPA Region III through Work Assignment Number 038-RDRD-03H6. Black & Veatch Special Projects Corp. (BVSPC) is the lead member of the JV for this work assignment.

1.1 Purpose and Scope

In accordance with the Remedial Design Work Plan and subsequent discussions with the EPA and DNREC, BVSPC presents this Final (100%) Design Criteria/Basis of Design Report (Report) for the Interim Groundwater Remedy of the SCD Site in New Castle County, DE. This Report represents the 100 percent level of completion for the circumferential containment barrier and the groundwater extraction, product recovery, and groundwater treatment systems to be employed at the SCD Site. Included in this Report are descriptions and objectives of the proposed groundwater remedy, design criteria and basis, a project delivery strategy, revised drawings and draft specifications, and a revised schedule and cost estimate.

1.2 Report Organization

This Report is organized into the following sections:

- Section 1 contains the Introduction to this document.
- Section 2 contains a brief description of the SCD Site, including physical setting, geology, hydrogeology, and groundwater characterization.
- Section 3 presents a description of the proposed groundwater remedy and each of its primary components.
- Section 4 presents the Design Criteria, including relevant design issues.
- Section 5 describes the Project Basis of Design.

- Section 6 contains BVSPC's proposed Project Delivery Strategy.
- Section 7 contains an overview of the Final Design Drawings.
- Section 8 consists of an outline of the proposed Project Specifications.
- Section 9 provides the estimated Remedial Action Schedule.
- Section 10 provides a Final Remedial Action Cost Estimate.

2.0 Site Conditions

2.1 Site Location and Description

The SCD Site is located on Governor Lea Road, in an industrialized area located approximately three miles northwest of Delaware City in New Castle County, Delaware. Residential and commercial properties are located within one mile of the facility (to the west). The SCD Site is bordered to the east by Occidental Chemical Company (formerly Diamond Shamrock Company) property, to the west by Air Products, Inc. and to the south by Governor Lea Road. Governor Lea Road separates the SCD Site from property owned by Ion Power, Inc., Premcor, Inc. and Connectiv (formerly Delmarva Power and Light). The Ion Power property was previously owned by Metachem, LLC, and the Premcor refinery was previously owned by Motiva Enterprises, LLC. The fence line of the former SCD/Metachem manufacturing facility (facility) encompasses approximately 25 acres. The SCD Site as a whole encompasses approximately 65 acres with its southernmost boundary adjacent to Governor Lea Road and its northern extent reaching to edge of Red Lion Creek. The site location is presented in Figure 2-1.

The SCD facility's wastewater treatment plant (WWTP) was used to treat process wastewater and process area stormwater runoff and includes an open catch basin (located near the center of the facility). The land between the SCD facility and the Red Lion Creek is wooded (trees typically less than 6 inches diameter). This area remains undeveloped with the exception of gravel roads (single lane), a sedimentation basin, two soil piles, and other features constructed as part of past remedial and monitoring activities. Near the Red Lion Creek and its unnamed tributary (located to the west of Air Products and the undeveloped area to the north of the facility), the terrain slopes sharply downward into wetlands areas surrounding these two water bodies.

2.2 Site History

The SCD facility was built in 1965 on approximately 46 acres of farmland that was previously owned by the Diamond Alkali Company. The Diamond Alkali Company had previously purchased the land from the Tidewater Refinery Company. Chlorinated benzene compounds were manufactured onsite from 1966 until the facility's closure in May 2002. Chlorine (piped in from the Occidental Chemical facility) and benzene (obtained primarily from the Premcor refinery located on the south side of Governor Lea Road) were the main raw materials for chlorinated benzene production processes. The facility underwent an expansion in the early 1970s to begin production of chlorinated nitrobenzene and to increase production of chlorobenzene, dichlorobenzene, and trichlorobenzene. Production of chlorinated nitrobenzene ended in the late 1970s, and the related capacity was switched to the production of chlorobenzene. The facility was also expanded in the late 1970s. Following that expansion, the SCD facility produced chlorobenzene, paradichlorobenzene, various isomers of trichlorobenzene, and chlorobenzene-based insulating fluids (Weston, 1993).

In December of 1998, SCD was sold as a whole to Metachem Products, LLC (Metachem). Metachem also purchased all of the land located between the facility boundaries and the Red Lion Creek that was known to have been impacted by SCD's releases. SCD (and its successor company, Metachem) have been identified as PRPs.

On April 30, 2002, following the bankruptcy of one of their major customers, Metachem announced that they would close the SCD facility. At that time, Metachem did not specify a closing date, and they left open the possibility of having the plant operate at a reduced capacity. Metachem closed the facility on May 4, 2002 and declared bankruptcy six days later (May 10, 2002). Shortly after this, Metachem abandoned the SCD Site (on May 14, 2002) to the EPA and DNREC. Since then, the USEPA and DNREC have been cooperating to implement an emergency cleanup action and determine an approach for the long-term rehabilitation of the SCD Site.

2.2.1 1981 Release and Response

In September of 1981, approximately 5,000 gallons of chlorobenzene were released during the transfer of chemicals to a railroad tank car. This release occurred near the western boundary of the SCD Site. Spilled chemicals traveled along the western boundary of the SCD Site and into the drainage ditch that runs westward along Governor Lea Road towards an unnamed tributary of the Red Lion Creek. As part of their response action, SCD recovered a portion of the surface runoff and removed surface soils in the release area and the drainage ditch located along Governor Lea Road. The excavated soil was then shipped to a permitted off-site disposal facility. This removal action was performed under the supervision of the Delaware Department of Natural Resources and Environmental Control (DNREC). As stated in the 1992 Remedial Investigation (RI) Report, SCD also conducted a limited subsurface investigation in the area of the release to determine the potential for migration of the spilled chlorobenzene into the underlying groundwater. Based on the results of this investigation, SCD and DNREC concluded that the potential existed for groundwater contamination to occur (Weston, 1992).

Following these actions, SCD, through its contractor, conducted additional investigation and assessment activities that included the installation of groundwater monitoring wells at various locations on the SCD property. The sampling and analysis conducted as part of these investigations revealed that the groundwater was contaminated with multiple types of chlorinated benzenes. It was subsequently determined that the primary source for the chlorinated benzenes in the groundwater was a leak that SCD detected in the WWTP's Catch Basin Number 1 in March 1976. According to the 1992 Feasibility Study (FS) performed by SCD's contractor, this catch basin was repaired by SCD in 1976, but the surrounding soils – in which contamination has been detected – were left in place (Weston, 1993).

To address the groundwater contamination, SCD installed a series of recovery wells and modified their existing WWTP to include an air stripper. An additional clarifier and tertiary sand filter were added to address the increased flow. A modified NPDES permit for the facility was issued by DNREC on January 21, 1985 and the modified system was brought on-line in 1986. At some point following their installation, the recovery wells and the associated piping fell into disrepair (largely due to corrosion issues) and suffered repeated shut downs. According to the EPA Emergency Removal Team (ERT) they were shut off permanently on April 3, 2003.

2.2.2 1986 Release and Response

A subsequent incident that occurred in January 1986 involved the failure of a 375,000-gallon tank located near the western boundary of the SCD Site. The spill resulting from the collapse of this first tank damaged three nearby tanks causing additional volumes of volatile organic compounds (VOCs) to be released. A total of approximately 569,000 gallons of various VOCs – including chlorobenzene, paradichlorobenzene and trichlorobenzene compounds – were released during this incident.

A portion of the spilled chemicals from this release solidified on contact with the paved areas of the SCD facility. Much of this material was subsequently recovered for reprocessing by SCD.

Some of the spilled chemicals from the 1986 release traveled northward to the northwest corner of the SCD property. From this point, they flowed down the western drainage gully and into a wetlands area surrounding an unnamed tributary of the Red Lion Creek located to the west of the facility. Another portion of the chemicals from the 1986 release flowed eastward across paved sections of the SCD property into the eastern drainage ditch. This material then traveled northward until it reached the facility's northern fence line. Although no historical data pertaining to the northeastern spill pathway outside the fence line was available, a part of this area was studied as part of the ongoing RI/FS.

As part of the initial response to this spill, SCD constructed a berm and a silt fence across the aforementioned tributary wetlands area. These were constructed to minimize the transport of contaminants into the Red Lion Creek. Contaminated sediments were excavated from the wetlands area to the north of the silt fence and placed in a lined sedimentation basin that was constructed to the north of the SCD facility fence line. Other contaminated materials were placed in soil piles that were constructed to the northwest of the facility fence line (Weston, 1992).

During the PRP's RI, water samples collected from between the two layers of the sedimentation basin's liner showed the presence of site contaminants. This, together with the age of the liner system, suggests that the contamination might have migrated from the basin into the underlying soil and groundwater. During the field activities conducted as part of this RD, it was determined that the silt fence that was installed in the tributary wetlands area had deteriorated to the point that it was no longer functional.

2.2.3 Catch Basin Number 1 Release

In March 1976, SCD determined that Catch Basin Number 1 – a settling basin in the facility's WWTP – had been leaking. The RI Report states that this basin was excavated at that time and replaced along with a portion of the surrounding underground piping. The RI Report also states that most subsurface chlorinated benzene contamination that is not attributable to the 1981 and 1986 releases is thought to have come from Catch Basin Number 1 (Weston, 1992). Although the RI Report mentions that integrity testing was being performed annually as of 1992, there is no indication of how long the basin had been leaking prior to its replacement.

2.3 Site Status

Because of the releases described above, the SCD Site was added to the National Priorities List (NPL) in 1987. A Consent Order (between DNREC and SCD) covering the performance of a Remedial Investigation and Feasibility Study (RI/FS) at the SCD Site was signed on January 12, 1988 and amended on November 14, 1988. The Record of Decision (ROD) for the site was completed on March 9, 1995, and an Administrative Order for Remedial Design and Remedial Action was signed on May 30, 1996.

Primary contaminants of concern (COCs) identified in the ROD include:

• Benzene	• Pentachlorobenzene
• Chlorobenzene	• 1,2,3,4-Tetrachlorobenzene
• 1,2-Dichlorobenzene	• 1,2,4,5-Tetrachlorobenzene
• 1,3-Dichlorobenzene	• Toluene
• 1,4-Dichlorobenzene	• 1,2,3-Trichlorobenzene
• Hexachlorobenzene	• 1,2,4-Trichlorobenzene
• Nitrobenzene	• 1,3,5-Trichlorobenzene

The Baseline Risk Assessment (BLRA) and subsequent RD activities have also identified polychlorinated biphenyls (PCBs), metachloronitrobenzene, and dioxins as site-related contaminants (ROD, 1995).

While the SCD facility is no longer an active manufacturing plant, chemical removal/site decontamination activities, involving EPA's ERT and DNREC, are currently in progress. As part of these activities, a portion of the SCD facility=s equipment is currently being operated by the ERT, DNREC, and their respective contractors. The facility's WWTP has been deactivated (along with the facility boilers) and the remaining treatment requirements (largely stormwater from process areas and tank pads) are being met through the use of sand filters and carbon adsorption. The rail siding located on the western side of the facility has been used utilized during chemical removal efforts, but its use has decreased as the process of removing liquid phase chemicals from the facility has moved on.

On September 23, 2004 Amendment Number 1 to the 1995 ROD was signed. This amendment specified off-site incineration as the Selected Remedy for disposal of approximately "1.3 million gallons bulk liquid wastes" that can not reasonably be returned to the commercial market. It is anticipated that the removal (and disposal) of these wastes [currently stored in various above-ground storage tanks (ASTs) and drums located on the SCD facility] will be accomplished over the course of 2005 and possibly the first part of 2006. Additional chemicals (totaling approximately 1.23 million gallons) are currently stored in approximately 4,100 polyethylene totes located in the facility's warehouse. Disposal of these chemicals will be handled under a separate Work Assignment.

2.4 Hydrogeologic Setting

The SCD Site is located in the Atlantic Coastal Plain Physiographic Province at approximately 12 miles from the Fall Line, which divides the Piedmont Province and the Coastal Plain. The Atlantic Coastal Plain in New Jersey and Delaware is underlain by a wedge-shaped mass of unconsolidated to semi-consolidated deposits that rest on crystalline bedrock and thicken toward the Atlantic Ocean.

The stratigraphy of the Coastal Plain Province includes interbedded fine- and coarse-grained sediments that consist of silt, clay, and sand, with gravel and lignite. The sediments were deposited in marine and fluvial environments from the Cretaceous through Quarternary periods. Because of shifting between deltaic and alluvial deposition, sediment types and textures can change greatly within short horizontal distances. Formations present at the site include the Columbia, Merchantville, and Potomac.

The Columbia Formation, the upper-most aquifer at the SCD Site, is a part of a north-south trending channel filled with unconsolidated sand and gravel that includes pockets of silts and clays. Over the majority of the SCD Site the Columbia Formation is underlain by either the Merchantville Formation, which includes dark gray to black, micaceous clay to silty-clay soil or the top of Potomac clays. Where these clays and silty clays are absent, it appears that the sands of the Columbia Formation are in direct contact with underlying Potomac sands. This is contrary to earlier assertions that the presence of a continuous clay/silty-clay layer largely prevented groundwater flow between the Columbia Aquifer and the Potomac Aquifer at the SCD Site.

Boring logs from two borings (SB-41 and TB-41) together with water quality data from the ongoing investigation of Potomac Aquifer suggest that some transmission occurs between the two formations.

The thickness of the Columbia Formation (based on 149 total borings and wells) ranges from 12 feet to 84 feet thick on-site, averaging approximately 56 feet thick with a general decrease in thickness to the north. On-site, the Merchantville, where present, has an average thickness of 10.2 and a maximum thickness of 22 feet. Based on regional available geologic information and the placement of area production wells, the Potomac

Formation appears to be on the order of 700 to over 1,000 feet thick in the area of the SCD Site.

To fill gaps in geologic and water quality data from previous investigations by PRP contractors, BVSPC collected additional data during the remedial design investigation and the ongoing Remedial Investigation/Feasibility Study (RI/FS) to fill various data gaps for the RD. In addition, a revised groundwater model was generated by BVSPC to account for, to the extent possible, the impacts of the redefined interrelationship of the Columbia and Potomac Aquifers. Portions of the BVSPC groundwater model report are summarized or included below. The entire groundwater model report is included as Appendix A.

2.4.1 Topography and Surface Drainage

The SCD facility is situated on a generally flat area of land bounded by Red Lion Creek to the north, an unnamed tributary to Red Lion Creek to the west and topographic highs to the south and east. A wooded area runs between the facility and Red Lion Creek. This area decreases in elevation from about 50 ft above mean sea level (MSL) at the facility to near sea level at Red Lion Creek. This area also exhibits a north-south trending surface water divide that splits the center of the site and wooded area.

The surface drainage is controlled by topographic highs near the SCD Site and Governor Lea Road and flows in a dendritic pattern toward the dominant drainage feature of Red Lion Creek. The surface water divide on the site guides drainage to the Eastern Drainage Ditch – a shallow (approximately two to four ft deep) drainage ditch that runs through the eastern portion of the facility – and a shallower drainage feature that runs along the facility's western boundary. These drainage features capture and direct stormwater to two weirs that are located in the northeastern and northwestern corners of the facility, respectively. These weirs discharge the stormwater offsite under NPDES permits with the western weir discharging to the Red Lion Creek via the unnamed tributary and the Western Drainage Gully, while the eastern feature discharges overland to the Red Lion Creek. In the wooded area, drainage is generally east-west controlled by the divide.

2.4.2 Recharge and Discharge

A water budget was developed by Conestoga-Rovers & Associates (CRA) in September 2001. They determined that essentially all of the recharge in the Red Lion Creek Basin is the result of precipitation. Based on annual precipitation data collected at the New Castle

County airport for the last 30 years, the average rainfall rate in the site vicinity is 43 inches per year (in/yr). According to the water budget for the drainage basin, a large percentage, 26 inches (59 percent) of the precipitation is lost to evapotranspiration, and about 3 to 6 inches (7 to 14 percent) is lost to direct runoff. Of the remaining rainfall, a relatively high percentage infiltrates as groundwater recharge. Based on this information, CRA determined that the groundwater recharge from precipitation infiltration is in the range of 11 to 14 in/yr. Using the average of this range (12.5 in/yr), CRA calculated the volume of groundwater recharge in the 7,700 acres of the Red Lion Creek drainage basin to be approximately 2.62 billion gallons per year (CRA 2001).

On the discharge side, the majority of the shallow groundwater discharges to Red Lion Creek and the surrounding marsh area. BVSPC has also identified 19 points in the area of the site that extract groundwater or surface water for industrial or residential purposes. These include seventeen wells and two surface water intakes; some of which are used to recover water for human consumption. Six of the wells are located down gradient of the Site. Four wells are cross- or near cross-gradient and seven wells are up gradient. The first two down gradient extraction wells are Premcor Well 91371, which is approximately 1.75 miles south-southeast of the site and Premcor Well 10066 which is approximately 0.75 miles south of the site. These wells are both screened in the Potomac Aquifer. The closest public potable water supply well screened in the Columbia Aquifer (Glendale Well Field Number 2) is cross-gradient and is located almost two miles to the west of the SCD Site. This well is operated by the Artesian Water Supply Company and has an average pumping rate of 250 gallons per minute (gpm) or 362,000 gallons per day (gpd) based on previous Delaware River Basin Commission (DRBC) data. Due to the relative distances and depths at which the aquifers are screened by listed wells, and the observed concentrations of COCs, it is highly unlikely that operating extraction wells have been impacted by the plume originating on-site.

Table 2-1 provides the location of these extraction points along with certain other characteristics.

In addition to the wells used for industrial or residential purposes, Premcor has three recovery wells (used for groundwater remediation purposes) screened in the Columbia Aquifer capable of a combined 120 gpm located on their property. As of 2001, these three wells were pumping at a rate of 72 gpm (CRA 2001). Additionally, Oxychem has placed groundwater extraction systems within the two containment barriers that were placed on their property. While these systems (which withdraw approximately 10 to 15 gpm total) pull water from within enclosed barrier areas, they do remove a certain portion of the precipitation that would otherwise go towards groundwater recharge. The five former recovery wells at the SCD facility had a combined capacity of 150 gpm when operating, but as mentioned previously, they had operating problems and have since been idled (in 2003).

Based on the groundwater withdrawals from industrial and public water users, as well as those remediation wells that are currently active, the total pumping well withdrawal is approximately 176 million gallons per year. Using these figures, the water budget calculates that Red Lion Creek discharges approximately 2.44 billion gallons per year. This roughly corresponds to stream flow measurements of about 10 cubic feet per second (ft^3/sec) collected by CRA (CRA 2001).

2.4.3 General Aquifer Characteristics

The Columbia Formation is the uppermost aquifer in the area of the SCD Site. The aquifer is unconfined and underlain in some areas by the Merchantville Formation silts and clays. In areas where the Merchantville Formation is missing, the upper Potomac Formation silts and clays underlie the Columbia Aquifer. In some areas of the site these clay and silty clay deposits form an aquitard at the bottom of the Columbia Aquifer, but recent test data from samples collected from the Potomac Aquifer indicate that contamination might have crossed this layer into the Potomac.

Groundwater flow within the Columbia Aquifer mimics the surface topography (flowing northward/northeastward towards the Red Lion Creek) while the flow in the Potomac Aquifer is primarily to the southeast (towards the Delaware River). On the northern, western and southern portions of the Red Lion Creek Watershed, a groundwater divide is assumed to exist in the Columbia Aquifer at the topographic highs of the watershed boundary.

The Red Lion Creek Watershed is bounded by the Delaware River to the east. Red Lion Creek discharges into the Delaware River approximately 6,000 feet east of the SCD Site. The water level of the Delaware River is tidal with changes on the order of 4.22 feet. Tidal gates installed near the mouth of the Red Lion Creek have minimized the influence of the river's tidal changes on the creek.

The water table forms the upper boundary of the Columbia Aquifer. The site water level may slightly fluctuate due to seasonal precipitation changes. Groundwater from the SCD

Site flows towards Red Lion Creek, an unnamed tributary located to the west of the Site, and the surrounding marsh area. The average hydraulic gradient of groundwater is 0.005 foot/foot to the north-northeast. The average aquifer hydraulic conductivity is estimated to range from 5 to 134 feet per day. Previous hydraulic conductivity estimates for test well TW-6 range between 184 to 441 feet per day.

The water level in Red Lion Creek is lower than the groundwater table in the Columbia Aquifer. USGS maps of the area indicate wetland areas with bank storage at several locations near the Red Lion Creek. Because groundwater level is higher than the Red Lion Creek water level, groundwater flows towards the creek and its tributaries and then discharges.

2.4.4 Site Specific Aquifer Characteristics

In addition to identifying the general characteristics of the Columbia and Potomac Aquifers, it is necessary to understand how the nature of the aquifers in the immediate area of the SCD Site will impact the Interim Groundwater Remedy.

Subsurface investigations at the Site and the adjacent facilities have indicated the presence of the following subsurface stratum (CRA, 2001):

- Fill – Gray clay from dredge spoils or orange to brown sands from local sources.
- Recent Deposits – Sandy and clayey marsh deposits including peat.
- Columbia Formation – Medium to coarse grained sand with varying amounts of gravel. It typically has distinct orange to yellow color. A basal sand and gravel layer is a key marker bed indicating the bottom of the formation. Lenses of silty clay or clayey silt occur scattered through the formation.
- Merchantville Formation – Generally a gray to green gray, glauconitic, micaceous silty clay.
- Magothy Formation – A fine to medium grained white and buff quartz sand with layers of gray to black silty clay containing lignite and pyrite.
- Potomac Formation – Variegated red, gray, purple, yellow and white clays and silts interbedded with three relatively thick silty sand units, which may provide economical quantities of water to wells.

- Crystalline Bedrock – Metamorphic (amphibolite and gneiss) and igneous (granite and gabbro) rocks.

2.4.4.1 Previous Hydrogeologic Investigations

To gain a better picture of the specific nature of the aquifers underlying the SCD Site, several hydrogeologic investigations have been performed at the site including the following:

- PRP Pump Tests

    1. A 72-hour pump test was conducted by Roy F. Weston on May 17, 1982 on TW-6.
    2. A 72-hour pump test was conducted by Roy F. Weston, Inc. in October 1990 on OR6A.
    3. A step drawdown test on April 30, 2001, and a 48-hour aquifer test and recovery from April 30 to May 2, 2001 on MW-40 were conducted by CRA.
    4. A 24-hour aquifer test was conducted by CRA between May 2 and 3, 2001 on MW-25.

- Water Level Measurements

    1. In August 1990, site wide water level measurements were collected by the PRP's contractor.
    2. On May 14, 2001 water levels were collected to provide a complete picture of the groundwater elevations at and in the vicinity of the SCD Site, including north of Red Lion Creek and east (OxyChem) and south (then owned by Motiva) of the SCD Site. Groundwater flows from south to north across the site and discharges to the Red Lion Creek. These measurements were collected by the PRP's contractor.
    3. On August 1, 2002, DNREC performed a round of water level measurements covering a large portion of the Site wells.
    4. Four rounds of water level measurements were collected by BVSPC as part of RI activities conducted during June, July, August, and September 2004. These measurements covered all accessible SCD Site wells as well as selected wells located on the adjacent Oxychem, Ion Power, and Premcor (then Motiva) properties.

- Tidal Investigations

    Staff gauges were installed and monitored in Red Lion Creek and the unnamed tributary. When the tidal gates were open, measured tidal variations were 4.22 feet and 2.85 feet in Red Lion Creek and the Delaware River respectively. The tide gates exhibit a strong influence on the Red Lion Creek water level fluctuation. When the tide gates are closed, the tidal change in the Red Lion Creek is minimal. Water level measurement results indicated that there was minimal tidal variation in the water level in the unnamed tributary.

- Stream Flow Measurements

  In Red Lion Creek, stream flow increases from west to east implying that the Red Lion Creek gains significant quantities of groundwater.

- Installation and Monitoring of Piezometers within the Marsh Area.

- EPA ERT Tests of Site Recovery Wells

  In December 2002, the ERT conducted step tests on RW-5, RW-2, and RW-3 while monitoring water levels at several nearby wells. The test on RW-5 was unsuccessful because of discharge piping failure (caused by corrosion). The test on RW-3 was successful, and while the test on RW-2 suffered mechanical and electrical problems, some data was collected. A rain event during the testing caused the monitor wells to recharge more than they were drawn down by the pumping wells. ERT interpreted the data from the tests (at that time) to suggest that there was an overlap of the cones of depression from RW-2 and RW-3. No data is available on the capture zones or other statistics related to the tests. Beginning in late January 2003, EPA Removal began pumping a total of 30,000 gallons per day from RW-2 and RW-3 and treated the extracted water onsite using carbon adsorption. During this time, the water levels in several nearby monitor wells were logged. After multiple mechanical problems (leaky lines, pump motors, etc.) and corrosion attack upon the equipment, the system was shut down for good in early April 2003.

BVSPC conducted additional activities to fill data gaps from previous investigations. These activities included Geoprobe soil borings, a membrane interface probe (MIP) investigation, design borings, cone penetrometer tests, and groundwater sampling. The information from these site investigations was used to conceptualize the site model.

2.4.4.2 Calculated Hydrogeologic Characteristics

In 1990, as part of the Phase I Remedial Investigation, Roy F. Weston conducted a 72 hour pumping test utilizing well OR6A as the pumping well and MW-11 and MW-12 as the observation wells. Although uncertainty surrounding the construction and locations of OR6A and the adjacent OR6B call into question the accuracy of this test, it is worth discussing because of the limited data available on the Potomac Aquifer.

According to the available records and subsequent investigations of the wells supposedly used in the test, they were all completed in the Upper Potomac Aquifer. In addition, water levels were recorded in 34 wells screened in the Columbia Aquifer. The purpose of the pump test was to determine hydraulic characteristics of the Upper Potomac Aquifer and to determine if vertical flow occurs through the silty clay and clay layer that was thought to separate the Columbia Aquifer from the Potomac. Based on the collected data, the PRP was unable to identify any connection between the aquifers (Weston 1992). Results of recent groundwater quality analyses – discussed in Section 2.5.5.1 – performed on samples collected from a Potomac Formation monitoring well (installed downgradient of the SCD facility) indicate that there is likely some hydraulic connection between the two aquifers in the area of the site.

It has been noted that the sand pack for MW-11 and MW-12 differ in length and that this difference could indicate that they are screened across different sand formations (DNREC, 2003). As observed in on-site and regional investigations inter-fingering of channel deposits and other depositional environments within the nearshore delta plain create variations in the lithology that are frequently not connected. It is possible that regardless of the relative locations of the wells (the two in question are approximately 2,000 feet apart) and the screened intervals chosen, that these Potomac wells are in different zones of the UHZ that are limited in extent and hydraulic connection.

In 2001, as part of the PRP's remedial design process, Conestoga-Rovers & Associates conducted aquifer testing utilizing monitoring wells and recovery wells completed in the Columbia Aquifer. The purpose of the test was to develop aquifer characteristics for the groundwater model that would be used to test various remedial design options. A new observation well, OBS-1, was installed for the test. In addition, a stream piezometer, TP-1, was installed in the marsh area just north of MW-25 to determine if there was any influence on the marsh water level.

A summary of calculated hydraulic properties from the two testing programs is presented in Table 2-2.

2.4.4.3 Water Levels and Flow

Shallow groundwater flow in the Columbia Aquifer under the SCD facility is controlled by the topography and wetland areas around Red Lion Creek. Shallow flow is predominately to the north toward Red Lion Creek. The deeper groundwater flow in the Upper Potomac Aquifer is controlled by the regional recharge areas and discharges to the Delaware River in the regional flow system. The Upper Potomac flow is generally to the southeast toward the Delaware River.

Groundwater level measurements were collected from the extensive groundwater monitoring well networks on and off-site. Based on the data, the shallow groundwater elevation ranges from approximately 16.5 to 17.5 ft above MSL in the southwestern area of the facility to approximately 3.5 to 4.5 ft above MSL near the Red Lion Creek. Measurements collected in 2001 during the operation of the recovery wells indicated an induced depression that extended along the line of the RW wells and had an elevation of 0 ft MSL (CRA 2001). In a June 22, 2005 e-mail, EPA Remedial Project Manager Hilary Thornton stated that the old groundwater recovery system, "suffered frequent mechanical failures and was shut down for weeks or months many times throughout its operational history, which spanned from the mid-1980s until spring of 2003." Mr. Thornton estimated that the extraction system may have been fully operational as little as 50% of the time. Consequently, any conclusions regarding the ability of the former extraction system to induce a cone of depression should be viewed with caution. Additionally, since the RW wells are currently inactive, it is assumed that any depression that they might have previously created is no longer present.

Groundwater elevations in the Upper Potomac range from about 5 ft MSL near OR6A and 1.5 ft MSL near MW-11 and MW-12. Weston noted an upward gradient between the two aquifers in the area of Red Lion Creek and the unnamed tributary and a downward gradient in the upland area under the SCD facility (Weston 1992).

In 2002, DNREC performed a round of water level checks at 48 wells located on the SCD property and the adjoining Air Products, Oxychem, and Ion Power properties. The Ion Power property was owned by Metachem at the time of this sampling. Data from this round indicated that Columbia Aquifer groundwater levels were highest (approximately 12 to 15 feet above MSL) under the southern and western portions of the facility and decreased to between 2.5 and 3.5 feet above MSL near the Red Lion Creek.

As part of an ongoing RI/FS, Black & Veatch personnel conducted four monthly groundwater level checks between June 10, 2004 and September 22, 2004. The last of these rounds was conducted in conjunction with the consultant for Oxychem as well as representatives for Motiva as part of a joint effort to obtain a better understanding of the groundwater flow throughout the area of the Site. Motiva was involved in this sampling because although they had already sold the facility to the south of Governor Lea Road, they retained the environmental liability for the facility. Water level readings for the wells located south of Red Lion Creek remained fairly stable over the four Black & Veatch sampling rounds with only one Potomac well (MW-12 at 1.28 feet) exhibiting greater than one foot in variation and most wells varying by less than 0.5 feet. As expected, the data showed that groundwater underlying the Site should flow in a south to north direction in the Columbia Aquifer and southeastwardly in the Potomac Aquifer. The water levels from all checks are provided on Table B3-1 of Appendix B.

2.4.4.4 Yields

Columbia Aquifer yields have ranged from less than 10 to greater than 500 gallons per minute and the Potomac from 10 to greater than 500 gallons per minute (Correlation of Hydrologic Units to Geologic Units Recognized in Delaware by the Delaware Geological Survey in the Delaware Coastal Plain, Delaware Geological Survey website).

The Columbia tapping recovery wells, RW-1 through RW-5, when operable, maintained average individual flow rates of between 10 gpm and 21 gpm during the years in which the groundwater collection system operated (CRA 2001). As noted previously, the EPA has stated that these wells experienced substantial operational difficulties and probably only operated less than 50% of the time. The only Potomac Aquifer well yield noted in previous work was for well OR6A at 410 gpm for 74 hours.

An aquifer test was conducted, pumping from MW-40 in the northwest corner of the site. The well log and construction diagram was reviewed as part of the current investigation, and it was determined that MW-40 taps the Columbia Aquifer in a portion of the site where the less conductive Merchantville is believed to be missing. An additional test was conducted pumping from MW-25, just east-northeast of MW-40 in the area to the north of the proposed barrier alignment. MW-25, located 156 feet from MW-40 is also located in this area that lacks the Merchantville. The test using MW-40 was conducted for 48-hours from April 30 through May 2, 2001. The MW-25 test was conducted for 24-hours from May 2 through May 3, 2001. Additionally, a two week aquifer test was performed on the site's recovery wells from May 7 through May 21, 2001.

The tests that were conducted using MW-25 and MW-40 as the extraction wells are more than two hundred feet beyond the barrier wall system as designed in the RD. The calculated hydraulic conductivity ranged from 77 to 131 feet per day with an average of 104 feet per day at MW-40. The calculated storativity ranged from 0.02 to 0.17 with an average of 0.095 at MW-40. At MW-25, in just under two hours of pumping, drawdown was at approximately 10 feet and fluctuated little from that measurement (CRA, 2001).

A similar setting is present near the recovery wells RW-1 through RW-4; however, they and their associated observation wells are located within the barrier wall as designed. The wells used in this test are screened within the Columbia Aquifer. The hydraulic conductivity was determined to be from 204 to 270 feet per day, averaging 237 feet per day. The calculated storativity for this pump test ranged from 0.06 to 0.09 with an average of 0.075.

On May 17, 1982, a 72-hour aquifer test was conducted on TW-6 by Weston. TW-6 is located along the western site boundary line in the area of the railroad in the southwest portion of the site. Transmissivities ranged from 3,676 square feet per day to 8,824 square feet per day. This corresponds with a hydraulic conductivity of 184 to 441 feet per day.

In 1990, Weston conducted two pump tests in OR6A which is screened in the Potomac. Transmissivities ranged from 1,440 square feet per day to 2,770 square feet per day based on responses observed in other Potomac-screened wells. Based on the observed response of Columbia-screened wells, the report indicated that there was not a hydraulic connection the Potomac and Columbia aquifers.

2.4.4.5 Groundwater Modeling

Using available site-related data, BVSPC compiled a three-dimensional groundwater model for the SCD facility which is presented in Appendix A. Although initially a two-dimensional model was employed for the design, this three dimensional model was developed to replace the earlier model (which has been eliminated from this RD document). This was done because of site contamination discovered in a Potomac-screened monitor well (PW-1) near the Site and questions about the continuity of the low permeability layer between the Columbia and Potomac Aquifers. Because of the limited amount of available data concerning the Potomac-Columbia interrelationship in the immediate area of the Site, the results of the three-dimensional model must still be used with caution.

The three-dimensional model has been used to assist in determining groundwater flow patterns, contaminant transport, and the impact of the proposed remedial barrier/groundwater treatment system. Three alternative pumping schemes were developed and modeled. In developing the model parameters, there was some uncertainty surrounding the presence or absence of contamination source material in some areas to the north of the sedimentation basin. Consequently, two of the alternatives used contaminant levels that remained constant outside the northern boundary of the containment barrier (representing a constant source in this area). One of these alternatives included pumping only from inside the barrier wall area. The second of these included two extraction wells to the north of the proposed barrier wall alignment to determine how effective this approach would be in limiting the spread of any contaminants left outside of the barrier. The third pumping alternative (which pumped only within the barrier wall area) used contaminant concentrations that declined over time in this area (representing greater impact from dispersion and degradation effects). A No Action alternative was included strictly for comparison purposes.

Because of the relative lack of available Potomac data for the area underlying the site, any model based conclusions regarding contaminant transport in the Potomac must be viewed (and used) with extreme caution. Some uncertainty also exists with regard to the model's Columbia Aquifer results. To address these uncertainties, the design is modular to allow expansion and incorporates safety factors into extraction and treatment capacities. Additional details on design features of the extraction and treatment systems are presented in Section 3.3 of this Report. Conclusions from the model include the following:

- Contaminated groundwater will migrate and discharge into the Red Lion Creek and its unnamed tributary indefinitely unless the source area is remediated or containment is achieved.

- An average total pumping rate of 18 gallons per minute (gpm) will be required to offset recharge from precipitation infiltration and maintain a stable water level within the barrier. Consequently a pumping rate in excess of 18 gpm will result in a drawdown of the groundwater water level within the barrier. In part because of uncertainty associated with the model, the extraction and treatment system has been designed to handle substantially higher flow rates than the 18 gpm predicted by the model.

- Simulation of the alternative that assumed no constant source located to the north of the northern extent of the barrier wall (with pumping only within the barrier) estimated that concentrations of contaminants in groundwater near the banks of Red Lion Creek would decline from approximately 162 to 172 mg/l to between 0.7 and 2.5 mg/l over the course of twenty years.

- The model indicated that site contamination would not reach the PW-1 well location even under the most conservative assumptions, but this indication is contradicted by the sampling data from that well.

- The alternative that included the exterior pumping wells was more effective at limiting the spread of Site-related contaminants to Red Lion Creek, but required the extraction and treatment of an additional 57 gpm. To account for this potential, the groundwater conveyance system and the treatment system were designed to handle a flow of up to 95 gpm and are modular to allow for further expansion if necessary.

- The model also indicated that although the low permeability layer separating the Columbia sands from the Potomac sands does inhibit the transport of contaminants between the two formations, it will not completely prevent it. This conclusion reinforces the need to draw down the Columbia Aquifer and eliminate/reverse any downward vertical gradient between the two formations.

2.4.4.6 BVSPC Geotechnical Investigations

As part of the RD process, BVSPC conducted multiple levels of investigation to better define the geology underlying the Site. Investigations were geared towards collecting needed geological and geotechnical information along and in the vicinity of the proposed barrier alignment and assessing the continuity of the clay layer separating the Columbia and Potomac formations. In particular, the data objectives included determining the barrier key layer, defining the soil types and quantifying physical parameters of the soil.

Historical boring logs and geotechnical testing results were gathered from several prior reports. This information was supplemented by field data resulting from BVSPC activities conducted over the last two years.

BVSPC advanced geotechnical borings in the northern area of the Site to investigate the subsurface along the original cutoff wall alignment. In Phase I of this study, seventeen borings (BSB 1-16 & 18) were installed using mud rotary techniques. Mud rotary drilling was used to simulate future slurry wall construction and assess soil stability, especially in areas of gravel seams. In addition to defining soil type, the investigation collected and analyzed samples for geotechnical properties. BSB borings from Phase I revealed that the site bottom changed dramatically at the far northern end of the Site and that the low permeability/clay layer that was expected between the Columbia and Potomac formations was unidentifiable or very thin in some areas adjacent to Red Lion Creek. After discussions with EPA, additional BSB borings (Phase II) were installed to the south of these areas. These additional borings (BSB 19-21) were advanced to the clay to provide data for a possible alternative barrier alignment which was subsequently determined to be preferable to the more northern alternative. Additional geologic information was obtained from nature and extent soil borings (NESBs) that were installed as part of RI subsurface soil investigation activities. Based on data gaps in the available geotechnical data, the design team moved some of the NESB locations closer to the barrier alignment and advanced most borings a few feet into the low permeability zone underlying the Columbia Formation. Certain geotechnical samples were also collected as part of this investigation for future analysis.

To address remaining questions regarding the suitability of the Columbia/Potomac interface low permeability zone as a key in layer for the proposed barrier wall, cone penetrometer testing ("CPT") was carried out along the proposed barrier wall alignment. Unlike the conventional borings, CPT involves the use of direct push technology and measures resistance to define lithology. By equipping the CPT rig with an electro-piezocone, CPT provides additional information regarding pore pressure at discrete intervals. This information has enabled the design team to better define the low permeability layer presence and composition at various critical locations around the site. The CPT borings were successful in showing the variation of the soils in the soil column in the areas of the planned slurry wall. Unfortunately, refusal limited the ability of the CPT rig to determine the thickness of the low permeability layer at some locations along the proposed barrier alignment. Additional details on the CPT results are included in Appendix C of this report.

Based on the results of these investigations and a review of other geological data (e.g., boring logs, well logs) for the site, maps of the top of the low permeability layer underlying the Columbia Formation at the site and the estimated minimum thickness of the low permeability layer were created. These are included as Figures 2-2 and 2-3, respectively. Details of the geotechnical investigations and resulting conclusions are presented as part of the Containment Barrier Design Report (Appendix B).

2.5 Groundwater Characterization

The quality of the groundwater underlying the SCD Site was characterized through sampling events conducted as part of the PRP's RI, during preliminary remedial design investigations performed by Metachem, during a 2002 DNREC investigation, as part of BVSPC's RD investigation, and during the ongoing Facility RI being conducted by BVSPC. Details from these investigations are summarized in the following sections.

2.5.1 Remedial Investigation

During the RI, SCD's contractor collected Columbia and Potomac Formation groundwater samples from monitoring and recovery wells located across the SCD Site and surrounding properties, as well as from well points located adjacent to the Red Lion Creek (Weston, 1992). A total of 82 samples were collected from 37 wells and three well points screened in the Columbia aquifer. Additionally, five samples were collected from four wells screened in the Potomac Aquifer. Complete details of the RI sampling effort are provided in the 1992 RI Report submitted by the PRP.

2.5.2 Metachem Design Investigations

Between 1999 and 2001, the PRP (through its contractor) conducted a Remedial Design Investigation (RDI) and a Supplemental Remedial Design Investigation (SDRI) in an effort to obtain data for use in the design of a containment barrier and extraction/treatment system. While the following sections summarize the methods and findings from these investigations, complete details can be found in the RDI and SRDI Reports that were submitted by the PRP.

2.5.2.1 Groundwater Investigation

As part of their RDI efforts, the PRP conducted a groundwater investigation to further characterize the nature and extent of the COC contamination in the groundwater underlying the SCD facility and adjacent properties. A total of thirteen borings were installed into the Columbia Aquifer at locations on the Air Products Facility, along the potential barrier wall alignment area, and to the north of Red Lion Creek. Six of these borings were converted to monitoring wells (MW-24, MW-25, and MW-33 through MW-36). These borings and wells were installed in accordance with the PRP's Remedial Design Work Plan (RDWP). Groundwater samples were collected from a total of 39 new and existing wells at the SCD Site and analyzed to further characterize COC contamination (CRA, 2000). During the PRP's SRDI, three additional monitoring wells (MW-37 through MW-39) were installed – in accordance with the PRP's RDWP – into the Columbia Aquifer north of Red Lion Creek. During this SDRI, groundwater samples were collected from existing wells MW-34, MW-35 and MW-36 as well as from the three newly installed wells (CRA, 2001).

2.5.2.2 Dense Non-Aqueous Phase Liquids Investigation

The PRP's 2000 dense non-aqueous phase liquid (DNAPL) investigation was conducted in two areas of the plant at which DNAPL was suspected from previous investigations to be present. This investigation included installation of seven borings in the vicinity of existing wells TW-5 and TW-30. These seven borings were converted to monitoring wells (MW-26 through MW-32). A DNAPL screening evaluation was conducted on these new wells using an interface probe and depth-discrete sampling with a Kemmerer sampling device. Soil samples from these locations were also collected and tested with Sudan dye. Based on the results of these initial tests, DNAPL recovery tests were performed on wells MW-28 and TW-30 using a pneumatic pump. Samples collected at this time were sent to an off-site laboratory for physical characterization of the DNAPL (CRA, 2000). Results of these tests are discussed below.

2.5.3 2002 DNREC Investigation

In August and September 2002, DNREC collected a total of 31 groundwater samples from 24 monitoring wells, three former recovery wells, and one well point located on the SCD property. In addition, single groundwater samples were collected from three wells on the Air Products property, two wells located to the north of Red Lion Creek on land currently owned by Premcor (then owned by Motiva), and five monitoring wells on the Oxychem property immediately to the east of the SCD property. All of these samples were analyzed for VOCs and SVOCs. As a follow-up to confirm results from the August/September sampling efforts, additional samples were collected from a Potomac-screened well (MW-12) and two wells located north of Red Lion Creek (MW-34 and MW-36) in January 2003.

2.5.4 BVSPC RD Investigation

As part of Remedial Design field activities, BVSPC performed a multi-phased investigation of the geology and groundwater underlying the SCD Site. This investigation included initial screening with a membrane interface probe/electrical conductivity (MIP/EC) unit, follow-up groundwater sampling, and installation of Flexible Liner Underground Technologies (FLUTe) Liners for detection of non-aqueous phase liquids (NAPLs).

2.5.4.1 MIP/EC Screening

The MIP employed a photoionization detector (PID), a flame ionization detector (FID) and an electron capture detector (ECD) to identify site-related contaminants. Although these detectors are not capable of determining the species or exact concentration of contaminants at any one location, they do provide an indication of the relative levels of contamination throughout the site. The results of the associated electrical conductivity (EC) study were used to evaluate the continuity of the clay layer that separates the Columbia Formation from the Upper Potomac Formation (the clay layer) at the site. To gain insight as to the northern extent of the groundwater plume at the site, a series of MIP/EC points were placed along the southern border of the Red Lion Creek (locations C14 through C24 on the MIP/EC data output). Other MIP/EC locations were also selected based on their potential to identify potential NAPL pools, and to provide added information regarding contamination extent and clay layer continuity.

The results from the detectors were compiled and plotted using the RockWorks2002 software package. Printouts of the resulting output and interpretation of these data are included in Appendix C.

2.5.4.2 Groundwater Sampling

Following completion of the MIP/EC study, groundwater samples were collected from 12 MIP locations and one soil boring location. The locations and depths from which these samples were collected were chosen based on the results obtained from the MIP detectors and field observations made by BVSPC personnel. All of the collected samples were analyzed in an onsite laboratory provided by Sentinel Mobile Laboratories. Split samples were collected from four of the locations and shipped to a contract laboratory program (CLP) lab to verify the onsite lab's results.

Additional groundwater samples were collected from Geoprobe borings installed to the north of the Red Lion Creek and to the west of the Red Lion Creek's unnamed tributary. Two of these borings were installed to the north of Red Lion Creek adjacent to monitoring wells MW-34 and MW-36. Another boring was installed approximately 100 feet to the west of MW-34. Six additional borings were installed along a line approximately 100 feet to the north of monitoring wells MW-34 through MW-38 on the Premcor property (then owned by Motiva) located immediately to the north of Red Lion Creek. A total of 10 samples were collected from these nine locations. Five borings were installed along the access road located on the Premcor property (then owned by

Motiva) to the west of the unnamed tributary, but groundwater samples could only obtained from two of these. These samples, collected from the Columbia Aquifer, were taken to determine the extent to which the site-related contaminants had migrated beyond the two water bodies.

2.5.4.3 Surface Water Sampling

BVSPC was tasked with conducting preliminary surface water sampling of the Red Lion Creek and its unnamed tributary. This sampling was performed to determine to what extent the water quality in these bodies has been impacted by the presence of site contaminants in the groundwater.

In an attempt to determine how water quality varies with depth in the Red Lion Creek, BVSPC personnel initially tried to collect water column samples from the creek using a Kemmerer Sampler. Because of the shallow nature of the creek, it was only possible to obtain multiple depth samples from one of the three sample locations. Grab samples were collected from the other two locations using regular sample bottles. Grab samples were also collected from both of the sampling locations in the tributary. A total of seven samples (including one duplicate) were collected and shipped to a USEPA designated CLP lab.

2.5.4.4 FLUTe Liners

Following the MIP/EC screening, NAPL FLUTe liners were installed at four locations selected because of elevated readings from MIP detectors and/or evidence that the underlying geologic had the potential for DNAPL accumulation. Locations selected for liner installation included areas near two MIP points (C-11 and C-12) as well as two locations above previously identified low points in the base of the Columbia formation (near monitoring wells MW-1 and MW-3). A fifth liner was installed to the east of monitoring well MW-6. This location was selected based on intense staining observed on the liner installed near MW-3 and historical evidence suggesting the presence of a trough in the clay layer leading from the area under the sedimentation basin towards Red Lion Creek. In each case, the liner was installed to the depth of the clay layer.

The liners were installed by using a Geoprobe to probe to the appropriate depth and then inserting the uninflated liner down through the geoprobe rods. The rods were extracted from the ground leaving the liner in place. Air and water were then pumped into the liner to inflate it. Each liner was left in place for at least one hour before being removed. After being removed, the liner was cut open and examined.

2.5.4.5 Potomac Aquifer Investigation

In an effort to obtain additional information on the impact of Columbia Aquifer contamination on the underlying Potomac Aquifer, a new double-cased monitoring well (PW-1) was installed to the east of the SCD facility in the area of MW-15. This location was selected because (although it is cross-gradient relative to the site from the perspective of the Columbia Aquifer's flow) Potomac Formation flow patterns place it downgradient of the SCD facility, and is thought to be outside the Columbia Formation groundwater contamination plume. Samples were collected from this well on November 14, 2003, December 10, 2003, and again in June 2004 and September 2004. These samples were analyzed for VOCs and SVOCs.

Based on the results of the 2003 PW-1 sampling events, two additional wells (PW-2 and PW-3) were installed into the Potomac Aquifer downgradient of PW-1. These wells were sampled in September 2004 and October 2004, respectively. Each of the three Potomac wells was constructed with an outer casing that was grouted into the clays that separate the Columbia and Potomac Aquifers and an inner riser extending into, and screened in, the Upper Potomac Formation. Potomac well placement within the SCD property boundaries was ruled out because of concerns about the potential transmission of site-related contaminants from the Columbia formation down into the Potomac Formation. Consequently none of the existing Potomac-screened monitor wells are located on the SCD property.

Sampling of the three existing Potomac-screened wells adjacent to the Site (OR-6A, MW-11, and MW-12) was conducted as part of the PRP's RI, DNREC's Site investigation, and BVSPC's RI.

At the request of the EPA and DNREC, a quarterly sampling program covering Potomac wells MW-11, MW-12, PW-1, PW-2, and PW-3 has been implemented. The first two rounds of samples were collected during the weeks of December 10, 2004 and March 25, 2005.

2.5.5 BVSPC RI/FS Investigation

In the summer of 2004 BVSPC sampled accessible wells on the SCD property. In instances where wells were clustered or otherwise grouped closely together only one of the group of wells was sampled. Additionally, ten surface water samples were collected from nine locations to determine the ongoing impact of the Site groundwater on the Red Lion Creek and its unnamed tributary. All of these samples were analyzed for VOCs, SVOCs, PCBs and pesticides, Target Analyte List (TAL) metals, hardness, alkalinity, chlorides, and total organic carbon (TOC).

Passive soil gas samplers were installed in the northern half of the facility and the area between the northern facility fence line and the Red Lion Creek to screen for areas requiring further investigation and to refine RI soil boring locations. Other samplers were placed in two portions of the Oxychem property to the east of the facility fence line. The results from these samplers tended to show that the heaviest contamination was confined to the area within the facility fence line and to certain areas immediately surrounding the sedimentation basin and soil piles. Sediment samples (co-located with the surface water samples), surface soil samples, and subsurface soil samples were also collected and analyzed as part of the RI activities at the Site. Details of these soil, sediment, and soil gas results will be presented and discussed in the upcoming RI Report.

BVSPC performed an initial review of surface and subsurface soil data from the RI activities and found that soil contaminant concentrations in the soil to the north of the northern end of the proposed barrier alignment are substantially less (on a part per million basis) than those found in the groundwater. However, field tests conducted during PRP investigation activities indicated the presence of DNAPL at one depth of one location (soil boring SB-4) to the north of the proposed barrier alignment. The remaining soil results tend to indicate that the northern area (which does not have a known history of industrial activities) should not act as a major source area once the wall is installed. Groundwater contaminants however are present at concentrations sufficiently high as to indicate the possible presence of DNAPL in this area. With the barrier cutting off the flow of contaminated groundwater from the south, it is anticipated that groundwater contaminant levels to the north of the barrier will decrease over time.

This RD is intended to serve as an interim remedy that can cost-effectively become part of a future final remedy as envisioned by the Record of Decision (ROD). This final groundwater remedy will combine with the corresponding soil and sediment remedy to provide an overall site remedy. The RD contains a monitoring component that will observe any trends in contaminant concentrations. These observations will be used to determine the most appropriate course for dealing with any contamination remaining outside the containment barrier. Among the potential technologies being considered for use outside the containment barrier are installation of additional extraction wells, addition of a barrier extension to surround any observed contaminated areas, and injection of chemical oxidants to treat the contaminated material in-situ.

2.5.6 EPA Well Pumping and DNAPL Recovery Investigation

In preparation for a test of the facility's wastewater treatment system, the EPA ERT installed DNAPL recovery systems at recovery wells RW-2 and RW-5. This was done, in part, to clear the system of any accumulated DNAPL and avoid clogging or other potential treatment train problems. A variable speed positive displacement pump was placed into RW-5 in October 2002 and set to remove DNAPL through steel tubing installed and screened at the bottom of the well. The pump was initially set to pump 15 minutes each hour at 4 gallons/hour. Approximately ten gallons of DNAPL were removed using this method. After the pump discharge had become primarily water, the well was allowed to recharge and the flow rate on the pump was reduced. No additional DNAPL was recovered. The DNAPL recovery pump was then moved to RW-2 in November 2002. The pump was again set to pump 15 minutes each hour at 4 gallons/hour. After approximately 11 gallons of DNAPL were recovered, the discharge changed to water. This well was also allowed to recharge and the pumping rate was again reduced, but no further DNAPL recovery was achieved. The ERT did not try to remove DNAPL from any other wells (EPA, 2005).

2.5.7 Nature and Extent of Contamination

Results from each of the investigations show that extensive contamination exists in the Columbia Aquifer groundwater underlying the SCD Site.

2.5.7.1 Nature and Extent of Dissolved COC Contamination

PRP RI SAMPLING DATA: The results of the PRP RI sampling effort (conducted in 1992) showed that there is extensive site-related contamination of the Columbia Aquifer in the area underlying the SCD facility and extending northward to the Red Lion Creek. According to the RI Report, the highest levels of site-related contaminants were observed between the areas of the two major documented releases (1981 and 1986) and recovery well RW-2. Only limited amounts of COCs were detected in samples collected from wells located on the Air Products property adjacent to the SCD facility's western boundary and the Occidental Chemical property located to the east of the facility.

No site-related contaminants were identified in any of the five samples collected from the Potomac Aquifer. None of the wells from which these samples were collected are located on the SCD facility.

PRP RDI/SDRI SAMPLING DATA: During their investigations between 1999 and 2001, sampling by the PRP showed elevated concentrations of COCs in the groundwater underlying the northern three-quarters of the fenced portion of the SCD property and the area between the facility fence line and Red Lion Creek. Analysis of samples from these areas showed the presence of seven of the 16 COCs at concentrations higher than their respective drinking water maximum contaminant levels (MCLs). North of the facility fence line, two wells (TW-50 and MW-25) had notably higher COC concentrations than other wells in this area. Within the facility fence line, higher concentrations of the COCs were found in groundwater samples collected near the source areas of the railroad siding and Catch Basin No. 1.

In general, COCs did not exceed MCLs in the Columbia Aquifer samples collected from locations north of Red Lion Creek or from wells located on the Air Products and Oxychem properties that are adjacent to the SCD facility. In samples collected from the area north of Red Lion Creek, only one sample (collected from MW-36) had a COC (benzene) present at concentrations greater than its MCL. Site-related contaminants were detected in samples from two of the three wells on the Air Products property, but none of the COCs were present at concentrations greater than their respective MCLs. Site-related contaminants were also detected in three of the five sampled wells on the Oxychem property located immediately to the east of the SCD facility, but only 1,4-dichlorobenzene was detected (in MW-17) at concentrations greater than an established MCL (CRA, 2000). During the PRP's SDRI, no VOCs were detected in the sampled wells (located north of Red Lion Creek) with the exception of toluene. There were also no SVOCs detected in these wells (CRA, 2001).

DNREC SAMPLING DATA: Additional groundwater data was obtained from a sampling event conducted in late August/early September 2002 (and the follow-up sampling in January 2003) by Delaware Department of Natural Resources and Environmental Control. These events included samples from 24 wells and one well point located across the Metachem/SCD property, as well as three wells on the Air Products facility to the west, five wells on the Oxychem property to the east, and two wells located on Premcor property (then owned by Motiva) to the north of Red Lion Creek.

Analyses of samples collected from the wells on the Metachem/SCD Property showed that there is significant contamination across the SCD Site with every sample having at least one (and almost always more than one) COC detected at concentrations greater than its MCL. Total COC concentrations were greater than 5 mg/l in samples collected from all but two locations (TW-1 and TW-3) across the site. The average total concentration of COCs detected in the samples from the Metachem/SCD property was 158.41 mg/l, with a median concentration of 107.1 mg/l, a high reading of 2,855.3 mg/l at MW-28 and a low of 0.214 mg/l at TW-1.

Samples collected from the Air Products wells (MW-10, MW-13, and MW-33) showed relatively low levels of site-related contaminants with concentrations of each COC less than 8 ug/l in all samples.

Samples collected from the southern Oxychem wells (MW-14 and MW-15) each had total COC concentrations less than 5 ug/l. Contaminant concentrations were higher in samples collected from the two northern Oxychem wells with total COC levels of 609 ug/l and 4,155 ug/l at MW-18 and MW-17, respectively. Benzene, chlorobenzene and 1,4-dichlorobenzene were the primary contaminants at MW-18, while mono-, di-, and trichlorobenzenes predominated at well MW-17. While minimal levels of three COCs were detected in the sample collected from the Potomac Aquifer well (MW-12) located on the Oxychem property, the January 2003 follow-up sampling of MW-12 showed no contamination.

The limited DNREC sampling conducted to the north of Red Lion revealed only low concentrations of tetrachlorobenzene compounds (approximately 1 ug/l each) detected in the two samples collected from the wells (MW-34 and MW-36). Follow-up sampling performed by DNREC in January 2003 to confirm these results failed to detect any contaminants in these wells.

COC data from the DNREC sampling event are included on Table 2-3 and are presented with the respective sample locations on Figure 2-4.

BVSPC MIP/EC DATA: Results from the MIP portion of this investigation (conducted in 2002) indicated that extensive contamination is present throughout much of the area underlying the SCD Site. Raw instrument data plots and interpolated contaminant contour maps for the three detectors are included in Appendix C of this Report.

Evidence of the presence of a clay layer separating the Columbia and Potomac Aquifer was provided by the results from the EC portion of the investigation. As with the data from the MIP detectors, the EC data was plotted using RockWorks2002. A plot of the raw EC data and the interpreted lithology fence diagram are included in Appendix C of this Report.

BVSPC RD GROUNDWATER SAMPLING DATA: In three out of the four split samples analyzed, total COC concentrations from the mobile lab analyses were lower (by an average of 37%) than the associated results from the CLP lab analyses. Only in the sample with the lowest level of contamination was this trend reversed.

With this in mind, the results of the groundwater sampling did show that, as predicted by the MIP detectors, contamination is widespread throughout the portion of the Columbia Aquifer that underlies the site. Highest levels of contamination were found in samples collected from beneath the central portion of the facility, to the north of the sedimentation basin, and at the northwest corner of the wooded area beyond the facility fence line (location C-14).

Further analysis of the groundwater data from this sampling event shows that benzene, chlorobenzene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene make up an average of approximately 79% of the detected site contaminants in each sample. 1,2,4-trichlorobenzene and 1,3,5-trichlorobenzene generally make up the bulk of the remaining COCs found in the samples. The percentages for the trichlorobenzene isomers are much higher in the three samples with total COC concentration less than 5 mg/l and in one deep sample collected at location C-11.

No site-related contaminants were detected in any of the samples collected from the Geoprobe borings installed to the north of Red Lion Creek and to the west of the unnamed tributary.

Results from the analysis of samples collected from Potomac monitoring well PW-1 have indicated the presence of four COCs. Although concentrations of these COCs have increased somewhat over the four sampling rounds, only benzene has been detected at concentrations above its MCL in any of the samples. In the latest round of sampling (performed September 7, 2004), chlorobenzene concentrations approached, but did not exceed, its MCL of 70 ug/l. No Site-related contaminants were detected in either PW-2 or PW-3.

COC data from BVSPC RD groundwater sampling efforts on the SCD property (conducted during January 2003) are included on Table 2-3 and are presented with the respective sample locations on Figure 2-4.

BVSPC RD SURFACE WATER SAMPLING DATA: COCs were detected in all but one of the surface water samples that were collected and analyzed as part of the RD investigation activities. Contamination was substantially higher in the samples collected from the unnamed tributary (619 ug/l and 60,940 ug/l) than in those collected from Red Lion Creek (non-detect to 107 ug/l). This was expected, given the high levels of contamination observed in the sediments of the tributary area. In the Red Lion Creek samples, total COC concentrations appear to be related to sample location, with the highest concentration found in the eastern-most (downstream) sample and relatively low concentrations found in one of the two upstream samples. Because of the observed direction of groundwater flow in the Columbia Aquifer, this concentration trend seems to indicate that surface water quality in the creek is being impacted by both sediment and groundwater contamination from the SCD Site.

COC data from BVSPC RD surface water sampling efforts are included on Table 2-4.

POTOMAC AQUIFER INVESTIGATION DATA: Of the six Potomac-screened monitoring wells located on properties adjacent to the SCD site, only PW-1 has consistently shown the presence of site-related contaminants. In one instance each, site contaminants were detected in samples from MW-11 (located across Governor Lea Rd. to the south of the Site) and MW-12 (located on the Oxychem property to the east of the SCD sedimentation basin). No site-related contaminants have been detected in wells OR6A (located upgradient of the Site), PW-2 (located across Governor Lea Rd. to the southeast of the Site), or PW-3 (located southeast of PW-2 near the Premcor property line).

In the June 17, 2004 RI sample collected from MW-11 chlorobenzene (2 J ug/L), 1,2-dichlorobenzene (2 B ug/L), 1,4-dichlorobenzene (2 B ug/L) were detected. Analysis of the August 2002 DNREC-collected sample from MW-12 revealed the presence of nitrobenzene, and the two tetrachlorobenzenes at J-qualified concentrations below 1 ug/L, but a sample collected in January 2003 failed to confirm this result.

With regard to PW-1, benzene (16 ug/L), chlorobenzene (16 ug/L), 1,2-dichlorobenzene (2 J ug/L), 1,4-dichlorobenzene (2 J ug/L), and chloroform (1 J ug/L) were detected in the November 2003 round of sampling. Although chloroform is a common laboratory contaminant, both chloroform and carbon tetrachloride (of which chloroform is a daughter product) were detected in samples collected in the Columbia Aquifer. Because these two contaminants were detected in some of the northernmost monitor wells (where the continuity of the low permeability layer is suspect) it is possible that the detected contaminants were transported from the Columbia to the Potomac. During the December 2003 round of sampling, only benzene (9 J ug/L) and chlorobenzene (6 J ug/L) were detected. In the June 2004 round of sampling, benzene (35 ug/L), chlorobenzene (29 ug/L), 1,2-dichlorobenzene (2 B ug/L), and 1,4-dichlorobenzene (3 B ug/L) were detected from the PW-1 sample. Samples collected in September 2004 had higher concentrations of benzene (77 ug/L), chlorobenzene (69 ug/L), 1,2-dichlorobenzene (4 J ug/L), and 1,4-dichlorobenzene (6 J ug/L). In the December 2004 sampling of PW-1, similar concentrations of benzene (53 ug/L), chlorobenzene (75 ug/L), 1,2-dichlorobenzene (7 J ug/L), and 1,4-dichlorobenzene (11 ug/L) were detected. Data from the March 2005 sampling of well PW-1, indicated increases in the concentrations of chlorobenzene (to approximately 140 – 150 ug/l), 1,2-dichlorobenzene (13 ug/l), and 1,4-dichlorobenzene (20 ug/l). Benzene remained in the 65 to 70 ug/l range in the latest sampling round. It is possible that differences in operator action, analytical method, sampling methods, or shipping conditions could explain some of the change in concentrations, but it does appear that the observed contaminants (which are the most mobile of the COCs) might be trending slightly upward. Because of the relatively small changes in observed contaminant concentrations it might be premature to interpret the general increase as part of a long term trend. Results of the newly instituted quarterly sampling program will be monitored to confirm/reject this apparent trend.

It should also be noted that for the data above, "J" qualifiers (where included) indicate that these are estimated values below the contract required quantitation limit (CRQL), and therefore the corresponding data might not be as accurate as unqualified values. The inclusion of the "B" qualifiers for certain results indicates that these detections might be the result of laboratory or field contamination.

BVSPC RI GROUNDWATER SAMPLING DATA: As expected, analyses of samples collected from the wells on the Metachem/SCD Property during BVSPC's RI activities showed that substantial site contamination remains in the portion of the Columbia Aquifer underlying the SCD Site. With the exception of the samples from well TW-22 near the eastern fence line of the facility and well TW-01 near the southwest corner of the facility, every sample had at least four (and typically five) COCs present at concentrations substantially greater than its respective MCL. The only COC with an MCL that was not detected was hexachlorobenzene. The average total concentration of COCs detected in the samples collected from the Metachem/SCD property was 92.53

mg/l, with a median concentration of 56.73 mg/l, a high reading of 344.85 mg/l at MW-20 and a low of 0.061 mg/l at TW-1. With few exceptions chloride and hardness levels were substantially higher in those samples collected from wells located to the north of the facility fence line than in those collected from within the facility fence line. Average chloride and hardness concentrations across the Site were approximately 218 mg/l and 169 mg/l as $CaCO_3$, respectively.

No COCs were detected in two (MW-10 and MW-13) of three of the wells located on the adjacent Air Products property. 757 ug/l of total COCs were detected in the sample from the remaining well (MW-33). This represents a substantial increase in the contaminant levels in this well relative to those observed during the 2002 DNREC sampling effort, but given the well's proximity to the SCD property line, the concentrations are not unexpected.

No COCs were detected in the samples collected from the southern Oxychem property wells screened in the Columbia Formation (MW-14, MW-15, and MW-16). It should be noted that MW-15 is adjacent to PW-1. This together with the lack of contaminants in the MW-15 sample and the generally upward trend in PW-1 contaminant concentrations, indicates that the contamination that was detected in PW-1 is unlikely to be related to the installation of PW-1. Instead, this suggests that the PW-1 contaminants are being transported through Potomac from other areas of the SCD Site.

COCs were detected in samples collected from the two northern Oxychem property Columbia wells with total COC levels of 231 ug/l and 1,006 ug/l at MW-18 and MW-17, respectively. These concentrations represent decreases of 63% and 77%, respectively when compared to the 2002 DNREC sampling numbers. Chlorobenzene was the primary (95%) contaminant at MW-18, while mono-, di-, and trichlorobenzenes predominated at well MW-17. COCs were detected in the sample collected from Potomac Aquifer well PW-1, but not from the Potomac well located farther to the north (MW-12) on the Oxychem property. Additional details on the Potomac well data are provided in the Potomac Investigation data summary presented above.

No COC detections were reported in the two Columbia-screened wells that were sampled to the south of Governor Lea Road. Similarly, no COCs were detected in two of the three sampled Potomac-screened wells located in this area. Additional details on the Potomac well data are provided in the Potomac Investigation data summary presented above.

Analysis of samples collected from the monitoring wells located to the north of Red Lion Creek (MWs 34 through 39) revealed the presence of low concentrations (ranging from 8 ug/l to 31 ug/l)of COCs in four of the six wells. While these numbers are higher than those observed in the 2002/2003 DNREC sampling, none of the COCs were detected at levels greater than 20% of their respective MCLs.

COC data from the RI groundwater sampling event are included on Table 2-5. Complete data tables from the sampling event are presented in Appendix D.

BVSPC RI SURFACE WATER SAMPLING DATA: COCs were detected in eight of the ten surface water samples that were collected and analyzed as part of the RI investigation activities. One sample (SW09_062304) that was collected from a small channel flowing from a point west of the unnamed tributary out to the Red Lion Creek exhibited extremely high COC concentrations (33,120 ug/l), but upon review of the sampling logs, it was noticed that this sample had very high turbidity (1404 NTU). Based on this information, it is suspected that much of the observed contamination was the result of contaminated sediments included in the sample. Excluding this suspect sample, samples from the northern reach of the unnamed tributary (SW02_062304) and the Red Lion Creek wetlands located to the northeast of the Site (SW04_062304) exhibited substantially higher COC concentrations (7,296 ug/l and 2,638 ug/l, respectively) than those collected from Red Lion Creek (non-detect to 66 ug/l) and the southern end of the unnamed tributary (12 to 47 ug/l). As might be expected, surface water COC concentrations tended to reflect the COC concentrations observed in the sediment samples collected from each location. In the Red Lion Creek surface water samples (again excluding SW09_062304), the highest concentration of contamination was found in samples located at the confluence of the tributary and the creek and to the east (downstream) of the Site, but no detectable contamination was found in two upstream samples (including the background sample collected to the west of Route 13). Because of the observed direction of groundwater flow in the Columbia Aquifer, this concentration trend seems to indicate that surface water quality in the creek is being impacted by contaminated sediments, tributary contamination, and groundwater contamination from the SCD Site.

COC data from BVSPC RI surface water sampling efforts are included on Table 2-4. As mentioned in Section 2.5.5 sediment data will be presented and discussed in greater detail in the upcoming RI Report.

RESULT SUMMARY: The data indicate that the Columbia groundwater underlying the SCD site remains heavily contaminated and has a very low pH (likely the result of some area specific activity). Data from the DNREC sampling and the BVSPC RD and RI groundwater sampling events were used as inputs for the base condition of the contaminant transport model that has been developed for the SCD Site. When these data were input and an initial set of contours developed, the contaminant plume extent was determined to be similar to that depicted in the study conducted during the 1992 RI.

At first glance an apparent drop in median COC concentrations is observed between the 2002 DNREC sampling and the 2004 BVSPC RI sampling, but when only those wells that were sampled in both efforts (14 in total) were included in the comparison, the median concentration actually increased by approximately 25 mg/l (approximately 34%). In addition, the median groundwater level in these 14 wells averaged approximately 2.8 feet higher in 2004 than in 2002. It is possible that these higher groundwater levels allowed additional contamination, previously adsorbed to soils above groundwater level, to enter the groundwater and increase (somewhat) the concentrations in site groundwater. It should also be noted that while six of the 14 common wells exhibited COC concentration increases of greater than 30%, four of the 14 showed decreases of at least 30%. These facts, together with the limited number of common sample points included in the comparison, make it difficult to identify any definite up or down trends in groundwater contaminant concentrations.

Notable concentrations of site contaminants were found in most of the surface water samples collected from the Red Lion Creek and its tributary. No such contamination was detected in RD groundwater samples collected to the west of the tributary. COCs were not detected in RD groundwater samples collected from the north of the Red Lion Creek by DNREC or during the BVSPC RD investigation, but relatively low concentrations of various COCs were detected in four of the five samples collected from these wells by BVSPC during RI/FS activities.

Taken together, this information indicates that the contaminant plume is largely stable with Red Lion Creek and its tributary generally acting as natural buffers against the northward and westward movement of the groundwater contaminant plume. Based on the varying concentrations detected in the northern monitoring wells, it is possible that the Red Lion Creek acts alternately as a contaminant source and a sink relative to the groundwater north of the creek.

While reviewing data from the recent RI/FS subsurface soil sampling activities, BVSPC found that soil contaminant concentrations in the soil to the north of the northern end of the proposed barrier alignment are substantially less (on a part per million basis) than those found in the groundwater. This reinforces expectations that soils in this area (which does not have a known history of industrial activities) will not act as a major source area once the wall is installed. With regard to groundwater in this area, dissolved contaminant concentrations are greater than 20% (and in the case of MW-20 greater than 35%) of their respective solubility limits in some wells. Dissolved contaminant concentrations exceeding 1%, 20%, or 33% have been viewed previously as potential indicators of the presence of DNAPL (CGWCA, 1994). This suggests that DNAPL is present in the Columbia Aquifer, but it does not indicate the relative size or a definitive location of any DNAPL accumulation. With the barrier cutting off the flow of contaminated groundwater from the south, it is anticipated that groundwater contaminant levels will decrease over time.

Based on the results of the RI soil sampling, profiles showing the total concentrations of COCs were developed for six of the seven sections of the proposed barrier wall alignment. Because of a move in the barrier alignment after the conclusion of the RI soil sampling effort, none of the collected samples were within a reasonable distance of barrier section A-B. Consequently no profile is included for this section. The remaining profiles are included as Figures 2-5 through 2-10. COC data from the RI soil sampling data is presented in tabular form on Table 2-6.

Results from the Potomac samples collected from the Potomac Aquifer investigation indicate that some site-related contamination has migrated from the Columbia Formation down into the Potomac Formation. Additional sampling of the area's Potomac wells (already implemented in the form of a quarterly sampling program) will be needed to delineate the extent of the Potomac contamination.

2.5.7.2 Nature and Extent of DNAPL Contamination

PRP RDI RESULTS: During the PRP's investigation, interface probe measurements and Kemmerer samples revealed DNAPL in well MW-28 only. Screening of the soil samples with Sudan Dye revealed the presence of DNAPL just above the top of the low permeability layer in well MW-28 and well TW-30. No DNAPL was detected in TW-5, MW-26, MW-27, or MW-29 through MW-30. Based on their study, the PRP concluded that a thin zone of DNAPL is present in the vicinity of the source areas and that a small isolated pool of DNAPL exists in a localized confining unit depression near well TW-30. During the DNAPL recovery tests conducted at MW-28 and TW-30, pumping rates of less than 0.4 to 0.065 gpm could not be maintained for more than 20 to 25 minutes (CRA, 2000).

BVSPC FLUTE LINER RESULTS: Three of the five FLUTe liners installed showed varying degrees of staining indicating the presence of NAPL at the locations. The liners installed at MIP/EC locations C-11 (near the truck loading area adjacent to the rail siding) and C-12 (near the WWTP's aeration basin) showed moderate staining between 50 to 55 feet bgs and 50 to 51 feet bgs, respectively. Intense staining was observed between 56 and 61 feet bgs on a liner installed just to the north of the site's sedimentation basin (near monitoring well MW-3). No staining was observed on liners installed near monitoring wells MW-1 and MW-6.

ADDITIONAL RESULTS: Based on known solubility limits of some of the COCs in water, COC concentrations in groundwater samples collected by DNREC and BVSPC provide additional evidence that DNAPL might be present at or near many locations. In particular, analysis of the DNREC groundwater samples collected from monitoring well MW-28 revealed the presence of 1,2,3,4-tetrachlorobenzene, 1,2,4,5-tetrachlorobenzene, and pentachlorobenzene at concentrations that exceed these chemicals solubility limits in water. In addition, concentrations of the two tetrachlorobenzene compounds exceeded their respective aqueous solubility limits in one DNREC sample collected from monitoring well MW-29 during DNREC's 2002 investigation. Analysis of an August 2002 DNREC sample collected from RW-2 indicated the presence of benzene, chlorobenzene, all three dichlorobenzenes, and 1,2,4-trichlorobenzene at concentrations above their respective solubility limits. These contaminants were also present (along with 1,2,3-trichlorobenzene) at concentrations indicating NAPL in an August 2002 DNREC sample collected from RW-5. Four compounds (1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene, 1,2,3,4-tetrachlorobenzene, and 1,2,4,5-tetrachlorobenzene) were detected at concentrations greater than their aqueous solubility limits in the deep sample collected by BVSPC from MIP/EC location C-11. Analyses of samples from other wells (showing contaminant concentrations higher than those that have been used to identify the possible presence of DNAPL) indicate that DNAPL might be widespread across the site.

As part of EPA ERT's efforts at the Site, they attempted to perform DNAPL recovery at wells RW-2 and RW-5 in August 2002. According to Mike Towle (the head of the ERT at the Site), they were able to recover a significant amount of product from each well (approximately 21 gallons from each) but recharge was extremely slow in one well and basically non-existent in the other. Mr. Towle stated (during a July 5, 2005 phone conversation) that although the initial recovery efforts were successful, it was decided that a long term recovery program would not be cost-effective given the ERT's mission at the Site. No additional recovery attempts have been made by the ERT. He did however specify that he believed that additional recovery would be possible from the two locations if sufficient recharge time (on the order of months) was allowed to pass between recovery attempts.

2.5.8 Well Information and Soil Boring Logs

All available well logs and soil boring logs for the site are presented with the MIP/EC and CPT output in Appendix C.

3.0 Project Description

3.1 Groundwater Remedial Objectives

No specific cleanup goals were established for the site contaminants of concern as part of the interim remedy. Although MCLs are not considered ARARs for interim groundwater remedies under CERCLA, they are frequently used in determining cleanup levels for final stage remedies. Additionally, Surface Water Quality Criteria will be used in determining treatment goals for extracted groundwater. These and other state and regional regulations can be considered potential ARARs and should therefore be considered in the Interim Groundwater Remedy RD. As part of the transition from an interim remedy to a final remedy it is expected that the EPA, in concert with DNREC, will develop cleanup and discharge goals for all impacted media. These goals will use ARAR-listed and risk-based limits to define a remedy that is protective of both humans and the environment. Table 3-1 presents chemical specific limits that might be taken into account when developing final groundwater cleanup goals and might play a role in determining discharge limits that will be put in place to meet the substantive requirements of the National Pollutant Discharge Elimination System (NPDES).

The ROD states that "restoration of groundwater to drinking water standards where DNAPLs are present may not be technically practicable" (ROD, 1995). Instead, the ROD cites the following objectives for the Interim groundwater Remedy:

- Prevent exposure to the contaminated groundwater;
- Prevent further migration of the contaminated groundwater;
- Prevent further degradation of the unnamed tributary to Red Lion Creek and of Red Lion Creek;
- Remove DNAPL pools, if identified during the RD, which act as a continuing source of groundwater contamination.

The ROD also specifies that additional data will be collected during the interim action to, "determine the extent of DNAPL and groundwater contamination." As mentioned above, both DNREC and EPA Region III (through its contractor BVSPC) have collected – and continue to collect – data regarding the water quality of the groundwater underlying the site and its impact on the surrounding surface water. Based on the additional data accumulated as part of the interim action, EPA, in consultation with DNREC, will determine the, "technical practicability of remediating the groundwater to health based levels," and subsequently decide on a final remedy for the groundwater. A final ROD that specifies the final goal and anticipated timeframe for the groundwater remediation will then be prepared by the EPA (ROD, 1995). It should be noted that ecological (environmental) based levels that protect the aquatic habitat and receptors in the unnamed tributary and Red Lion Creek will also be taken into account when determining the final groundwater cleanup standards and remedy for the SCD Site. It is possible that the EPA and DNREC could determine that remediation of the Site groundwater to the required health based and ecologically protective standards is impractical given available treatment technologies. Regardless of this determination, it is expected that the Interim Remedy will become part of the Final Groundwater Remedy for addressing Columbia Aquifer contamination related to the Site.

3.2 Preferred Remedial Alternative

Two remedial alternatives for groundwater were presented in the ROD. EPA evaluated these alternatives as well as the No Action Alternative against the nine criteria specified in the National Oil and Hazardous Substance Pollution Contingency Plan at 40 CFR § 300.430 (e)(9)(iii). The EPA preferred remedial alternative (as specified in the ROD) involves the following components:

- Implementation of institutional controls in the form of deed restrictions on the affected properties;
- Maintenance (or replacement, if necessary) and operation of the existing groundwater extraction wells – These wells have become inoperable and will only be replaced if determined to be necessary for plume capture or hydraulic head control;
- Installation of a groundwater containment system (consisting of a physical barrier such as an interceptor trench, sheet pilings, or slurry wall) along the shorelines of the unnamed tributary and Red Lion Creek – Following discussions between DNREC and EPA personnel, it was decided that the use of a circumferential barrier wall would be preferable to a cutoff barrier because of the lower operating and maintenance costs for the associated groundwater treatment system. Because of constructability issues and observed geologic structures in the northern end of the proposed barrier alignment, the EPA, in consultation with DNREC, approved moving the northern extent of the barrier southward away from Red Lion Creek. At EPA's request, a conceptual level discussion of various cap design/installation

alternatives has also been included as part of the containment barrier design report;

- Treatment of extracted groundwater and discharge of treated water to the Delaware River using the facility's existing treatment system under that system's NPDES permit – Because the manufacturing operations have ceased and the facility's WWTP has been decommissioned this design document includes a new treatment plant (incorporating filtration, air stripping and carbon adsorption for organics removal, and green sand filtration for metals removal) that will be constructed at the Site for treatment of extracted groundwater. Additionally, the closure of the WWTP and past problems with the plant's existing discharge line will require the installation of a new line that discharges to the Red Lion Creek along with a new NPDES equivalent permit for the discharge;
- Treatment of air emissions from the groundwater treatment system in the facility's boilers – Because the existing boilers have been shut down in conjunction with the decommissioning of the WWTP, additional controls will be put in place to treat air emissions from any groundwater treatment system that is implemented. Because of state restrictions on the placement of thermal oxidizers in the coastal plain, as well as technical difficulties associated with treatment of off-gas containing high concentrations of chlorinated compounds, this design includes vapor phase carbon units for off-gas treatment;
- Installation and operation of low volume product recovery wells with off-site disposal of recovered DNAPL in accordance with RCRA – The circumferential barrier included in this design should contain the observed concentrations of DNAPL. Furthermore, the majority of the observed DNAPL accumulations do not appear to be substantial enough to allow consistent cost-effective recovery. Based on these observations and discussions with EPA and DNREC, DNAPL recovery will consist of periodic pumping of existing and replacement monitor wells in areas where DNAPL has previously been recovered/observed;
- Previous soil and sediment cleanup levels are currently being reviewed by EPA with an eye towards possible revision. Once final soil and sediment cleanup levels are established, contaminated sediments in the areas surrounding the Red Lion Creek and its unnamed tributary will be dealt with as part of the soil and sediment RD that is currently underway; and
- Installation of other measures (e.g., additional groundwater extraction wells) to ensure that the elevation of the Columbia Aquifer does not exceed the seasonal

high groundwater table that existed prior to construction of the barrier – This design includes six new extraction wells to be placed at various locations within the alignment of the proposed containment barrier. These extraction wells will be used to lower the Columbia aquifer groundwater level within the containment barrier, and reduce/eliminate the potential for the site contaminants to spread into the lower aquifer. Once a neutral or upward gradient is established between the Potomac and Columbia Aquifers the withdrawal rate on the wells will be reduced to maintain the modified gradient;

This design document addresses the above components.

As mentioned previously, aside from one soil interval sample for which a field test indicated the presence of DNAPL, there is a lack of significant observed soil contamination in the area to the north of the northern end of the proposed barrier alignment. The lack of documented industrial activity in this area also tends to indicate that soil contamination should be less or missing in this area.

With regard to groundwater, dissolved contaminant concentrations in samples collected from wells located to the north of the proposed barrier alignment (but south of Red Lion Creek) are greater than 20% (and in the case of MW-20 greater than 35%) of their respective solubility limits. Dissolved contaminant concentrations exceeding 1%, 20%, or 33% have been viewed previously as potential indicators of the presence of DNAPL (CGWCA, 1994). This suggests that DNAPL is present in the Columbia Aquifer, but it does not indicate the relative size of any DNAPL accumulation.

Based on these soil and groundwater data it is projected that groundwater contaminant levels in the areas between the barrier wall and Red Lion Creek will likely decrease over time once the installation is complete. Additionally, the vertical gradient between the Columbia and the Potomac is expected to be generally neutral to upward in this area following the installation of the containment barrier. This should prevent/minimize transmission of dissolved site-related contaminants from the Columbia to the Potomac. Consequently it is proposed that this area first be monitored to determine whether contaminant levels decrease as expected. If it is determined that contaminant concentrations to the north of the barrier wall are not decreasing at an acceptable rate, additional measures (e.g., extension of the northern end of the wall, injection of chemical oxidants, or addition of extraction wells in this area) will be implemented to address the contamination. If pumping is required, it is anticipated that two wells will be installed and extract a total of approximately 57 gpm. This extraction volume is based on the results of the model included in Appendix A.

3.3 Final Design

The major components of the design for this site are the physical barrier, groundwater extraction wells, treatment system, the treatment building, and conveyance systems. The presented design is based on a circumferential wall with extraction wells withdrawing groundwater from within the wall at an initial rate of approximately 43 gpm. The overall design of the containment/extraction system was based in part on the results of the three dimensional groundwater model included in Appendix A.

3.3.1 Site Development

For the preliminary design, topographic surveys were obtained for the SCD Site. The resulting base map has been incorporated into the attached site plans that are presented in Appendix E.

A large portion of the area where the barrier wall and treatment building are to be constructed is wooded. Portions of these areas will require clearing and regrading prior to construction. If not previously addressed as part of the Soil/Sediment remedial action, the access roads located to the north of the facility fence line will need to be upgraded to handle construction traffic. A work platform (following the alignment of the barrier wall) will be constructed as part of the slurry wall construction process.

Two stormwater and sediment stabilization basins will be constructed to ensure that barrier wall and treatment system construction activities will adhere to DNREC stormwater management requirements. The existing weirs will be removed/demolished as part of the work platform construction. Trenching will be required to install conveyance piping from the wells to the treatment building and from the treatment system to the treated water discharge point in the stormwater/sediment stabilization basins. To minimize the length of discharge piping and address concerns regarding the impact of site contamination on construction activities, the treatment system building will be located in a central portion of the Site to the north of the manufacturing facility structures. This location will also minimize the effect of construction activities on facility remedial operations. Because it has been determined that existing water and stormwater lines have degraded, new lines will have to be installed and routed to the treatment building. Electrical and natural gas lines will be routed from existing facility connections.

Because the two soil piles containing contaminated materials from the 1986 spill response are located along the proposed barrier wall alignment, they will have to be relocated to another area of the site. The soil piles will be combined and staged on a new temporary storage area that will be constructed at the site. The new staging area will constructed on a compatible geosynthetic base (likely a polyurethane coated material) and will use a geosynthetic cover (such as XR-5) weighted down with ultraviolet resistant sandbags to prevent wind dispersion of the contaminated material. A final detailed design of the staging area will be provided by the RA construction contractor and will be required to meet the performance specification included as part of Appendix F of this document.

This staging area will also be used to store contaminated spoils from trenching activities related to the construction of the barrier wall. Only those materials in which contaminant concentrations are greater than those considered appropriate for use as barrier backfill will be placed in the storage area. To avoid delays related to field determination of contaminant concentrations, decisions on which portions of the trench spoils will be wasted will be made based on preexisting soil data before field activities begin. Soil reuse contamination limits will be set based on compatibility test results and guidance from EPA and DNREC. To minimize contaminant levels in leachate from the new storage pile, the dryer soil pile material will be kept separate from (and placed upgradient from) the wetter trench spoils.

BVSPC has met with personnel from DNREC's Stormwater Division to discuss potential stormwater plan requirements for this project. An interim Sediment and Stormwater Control Plan will be submitted to DNREC, but development of a final stormwater management plan is not practical at this juncture given the uncertainties regarding the final grading of the site (i.e., will a cap be put in place and if so what type), the final disposition of the soil piles, the sedimentation basin, and other contaminated soils and sediments (to be handled as part of the Soil and Sediment RA).

3.3.2 Extraction Wells

Available information from the RI, the PRP's RDI, and the PRP's SRDI indicates that suitable water bearing zones should be encountered at each of the projected extraction well locations. Use of six (6), 6-inch diameter extraction wells is anticipated with each well installed to a depth of approximately 60 to 70 feet bgs. Because of possible chemical and pH compatibility issues, these wells will be constructed of American Iron and Steel Institute (AISI) 316 stainless steel. Although it is approximately 30% more expensive than AISI 304 stainless steel, AISI 316 stainless was selected because of its greater resistance to elevated chloride levels such as those observed during the BVSPC RI/FS sampling of some monitoring wells.

The anticipated well depths and screening intervals are based on boring log information, cone penetrometer testing (CPT) results, and electrical conductivity data showing the presence of a low permeability (primarily clay) layer that separates the Columbia and Potomac Aquifers. The 6-inch wells will be installed by drilling a 10-inch diameter hole to allow room for sand pack and grouting. Approximately 10 feet will be screened with 0.030" slotted AISI 316 stainless steel and a U.S. Silica FilPro #1 (or equivalent) sand pack. Well design was performed to ensure that the filter pack pore space and the screen slot openings allow formation water to move through the well and minimize the movement of filter pack and aquifer materials into the well. The sand pack and screen slots have been specified for three of the six extraction wells based on grain size data from NESB borings collected during the Remedial Investigation. Although the remaining three well locations were not close enough to any boring for which grain size data exists, the relative similarity of Columbia Aquifer materials (determined by review of logs from existing and former wells and borings) across the projected extraction area should allow the use of similar materials at these locations as well. To confirm these results, it is expected that confirmatory grain size analyses will be performed at each location during well construction. Selection of the well screen slot size also took into account the collapse potential and required tensile strength of the anticipated well construction. Well design calculations are presented in Appendix G.

MIP/EC data, other historical sampling data, and the general nature of the groundwater contamination (primarily composed of contaminants with specific gravities greater than 1.0) suggest that heaviest contamination will be encountered at or just above the low permeability layer separating the Columbia and Potomac Aquifers. To ensure maximum capture of dissolved contamination and increase the potential to capture DNAPL (as requested by EPA), the extraction wells will be screened from this layer up ten feet. It should be noted DNAPLs entering the system have the potential to foul the extraction system and/or portions of the treatment system. Alternatively these DNAPLs could overwhelm the system and cause treated water quality to exceed the NPDES limits. If such fouling becomes problematic, one of two adjustments will be made to the system:

either the pumps will be raised approximately one to two feet or an additional DNAPL removal system will be added to the treatment train.

The remaining length of the well will be constructed of schedule 40 AISI 316 stainless steel casing with weld joints. Welded joints have been selected instead of threaded joints to minimize the potential for corrosion. The annular space between the casing and the wall of the boring will be grouted with a bentonite/cement grout in accordance with Delaware well construction guidelines. Installation will include a 4 ft x 4 ft x 3 ft traffic rated and waterproof precast concrete vault box for each well. All of the necessary drilling is expected to be through unconsolidated overburden material consisting of sand and silty sand. From past drilling experiences in the field, advancing the auger at these locations will not require special drilling techniques.

The groundwater model (Appendix A) assumed six (6) wells with extraction rates of approximately three (3) gallons per minute (gpm) at all pumping locations for a total withdrawal rate of approximately 18 gpm. This model was based on an extraction system that maintained a stable hydraulic head when considering only infiltration through the barrier wall and from rainfall. In designing the treatment system presented herein, it was decided to increase the total pumping capacity to allow for a reduction/elimination of the downward hydraulic gradient that exists between the Columbia and Potomac Aquifers at the Site. This increased pumping capacity will also allow for future expansion of the extraction system (e.g., to deal with contamination remaining outside the barrier wall) and allows a needed factor of safety given the lack of available data regarding the transmissivity between the two formations.

To achieve a neutral to upward vertical gradient between the Potomac and the Columbia within three years, it is estimated that the total initial extraction rate for the six wells will be approximately 43 gpm. This rate assumes a porosity of 30% and a required average water level reduction of approximately 11 feet. Historical pumping rates from the five former recovery wells on the Metachem/SCD property – as well as those on surrounding properties – suggest that this rate should be achievable. Pump tests will be conducted on each of the wells during installation to confirm the practicality of this approach. If any of the proposed extraction rates are determined to be unrealistic, additional wells might be required to meet the desired total system extraction rate. Based on anticipated flow rates, a submersible well pump (equivalent to a Grundfos 10Redi-Flo3-100 pump) – each equipped with a motor rated at 0.845 horsepower (hp) – would be installed at each location and include wiring and instrumentation. In determining pump sizes, a safety factor of 30% was applied to the anticipated well flow rates resulting in a total design system extraction rate of 56 gpm. In addition, a life cycle cost approach was used when choosing between multiple pumps that met pumping requirements. Friction head calculations that were used in pump selection and well design calculations are included in Appendix G.

3.3.3 Treatment System

Section 2.5 discusses the groundwater characterization and contaminants of concern for the SCD Site. Table 3-1 provides the relevant regulatory limits that might be used in determining cleanup goals and/or NPDES discharge limits for the treatment system. A new NPDES equivalent permit will be acquired for the treated water discharge to the Red Lion Creek. The clean up goals for COCs and permit requirements for metal and organic contaminant discharges will determine the groundwater treatment required by the system. Air permit requirements will determine any air treatment. Sizing for the air stripping, liquid phase carbon, and vapor phase carbon portions of the proposed system was performed using Carbonair's STAT, Liquid Phase Carbon, and Vapor Phase Carbon models, respectively.

The following is a list the anticipated treatment components required for the treatment system. Redundant process pumps are included in the design to minimize any potential downtime due to malfunction or maintenance requirements. In sizing the treatment system components, a maximum design flow rate of 95 gpm was used. Using this sizing the system will be able to handle a 38 gpm flow rate during the initial draw down period plus a additional 57 gpm if it is determined that additional pumping is required to contain contamination remaining outside the barrier wall. While sizing the system to treat a maximum of 95 gpm would extend the draw down period slightly, this design reduces overcapacity and will still allow the system to handle flow rates as low as 18 gpm if it is determined that additional external pumping is not required after the drawdown period is complete. In addition, the modular nature of this design allows for expansion if it is later determined that higher withdrawal rates are needed to draw down the Columbia or contain contamination left outside the barrier wall. A more detailed description of the treatment system design is presented in specification Section 11430 and on drawings GP-2 through GP-6.

- Influent holding tank – This tank will have a 5,000 gallon capacity and will allow some settling in case any DNAPL enters the system from the extraction wells.

The influent tank will also allow mixing of the groundwater coming in from the six extraction wells. This mixing will even out the concentration of the contaminants in the influent entering the system.

- Initial Filtration System – Four bag filters sized to handle at least 95 gpm fed by a 5.5 horsepower (approximate) feed pump from the influent tank. The bag filters will be arranged so that two 25 micron bag filters operate in parallel and feed two 10 micron bag filters also operating in parallel.
- Air Stripper – A low-profile tray (6 trays) type air stripper capable of treating 95 gpm and equipped with a blower rated for approximately 900 cubic feet per minute (cfm). A low-profile tray stripper was selected to ensure ease of maintenance/cleaning.
- Vapor Phase Granular Activated Carbon Units – Two 10,000 lb (approximate) units, in series, to remove organics from the air stripper off-gas, preceded by a duct heater to serve as humidity/temperature control for the air flow from stripper.
- Secondary Filtration System – Two bag filters sized to handle 95 gpm fed by a 5.5 horsepower (approximate) feed pump from the air stripper. These will be 10 micron bag filters and will operate in parallel.
- Liquid Phase Granular Activated Carbon Units – Two units (approximately 2,500 lb capacity each) capable of handling 95 gpm, in series, to serve as a polishing step for secondary removal of organics prior to discharge.
- pH adjustment – Although aeration (achieved in the air stripper) will increase the pH of the water somewhat, it is very likely that additional pH will be required. The added pH adjustment will be accomplished through the addition of 50% sodium hydroxide (NaOH) solution and will raise the water pH to between 7.5 and 8.2. This adjustment will help meet the projected pH discharge limits and help convert aluminum present in the water to the insoluble aluminum hydroxide [$Al(OH)_3$] form which will be removed on the green sand filters. In addition, this pH adjustment is required to ensure that the green sand filter functions properly. The adjustment was placed after the air stripper to take advantage of the aforementioned pH rise from aeration, and to minimize fouling of the air stripper.
- Metals Removal System – A green sand filter sized to handle 95 gpm at a loading rate of between 1.0 and 2.5 gpm/square foot will be used to remove iron and manganese from the waste stream. Potassium permanganate will be added upstream of the filter to aid in the oxidation of these metals. It is expected that the filter will capture not only the iron and manganese but will also remove insoluble

aluminum hydroxide that was formed as the result of the preceding pH adjustment. Backwash water from the filter will be captured in a settling tank and decanted for reprocessing in the treatment system. The resulting sludge will be pumped out of the tank and trucked off-site for treatment and disposal.

- Depending on the discharge limits that are put in place for other metals (particularly copper and zinc), it might be necessary to add an ion exchange system using a chelating or other selective resin to remove these metals from groundwater to concentrations that will meet the groundwater discharge limits. Because the organic materials (i.e., the COCs) would likely foul an ion exchange resin, the system would be placed after the liquid phase carbon units. This system would also include a backwash containment tank because the system will not have access to a sanitary sewer system. Backwash and regeneration water would be trucked off-site for treatment at an industrial wastewater treatment plant.
- Treated Water Storage Tank (temporary)
- Programmable Logic Controller (PLC) and a Supervisory Control and Data Acquisition (SCADA) system.

Ultraviolet (UV) oxidation was considered for treatment of the contaminated groundwater, but was eliminated after discussions with vendors indicated that the technology would not be cost effective in this application. Elimination of the air stripper and vapor phase carbon units in favor of larger liquid phase carbon units was considered in an effort to simplify the treatment system, but this choice was rejected because of substantially higher projected carbon usage and long term operating costs. High rate anaerobic treatment (fluidized bed reactor) was considered but rejected because of higher operator skill levels and long recovery times that are typical in the case of failure of such systems.

Because of high operating expenses related to using NaOH, other methods of pH adjustment were considered. Lime addition was rejected because of expected difficulties in maintaining stable pH adjustment levels and high operator/maintenance costs associated with these systems. Limestone filtration was also considered because of its substantially lower operations costs and ability to remove some metals, but it was not incorporated because of substantial doubts about the technology's ability to provide the required rise in pH.

The use of chemical precipitation alone was considered for the metals removal function, but it was rejected because of sludge production, complexity, and space limitation issues.

Additionally, precipitation alone might not have been able to meet the anticipated requirements for a new NPDES permitted discharge.

Ion exchange was considered for metals removal, but to avoid fouling of the ion exchange resin, the system would have to be placed after the liquid phase carbon units. Unfortunately, the manganese present in the groundwater would foul the carbon units if it is removed prior to these units. This conflict ruled out the use of ion exchange for the bulk of the metals requirements of the system.

Thermal and catalytic oxidation were both considered for treatment of the air stripper off-gas, but were ruled out (at least temporarily) because of the prohibition on the use of these technologies in the Delaware Coastal Plain (discussed in Section 5.1.2). Additionally, operational issues (e.g., increased equipment corrosion, poisoning of catalysts) resulting from relatively high levels of chlorinated compounds in the waste would most likely make the use of oxidizer technology impractical. Other off-gas treatment technologies that were considered included the use of a condenser and destruction by routing the gas through an internal combustion engine. These technologies were discarded after an initial review of their capabilities relative to the projected off-gas concentrations and flow rate.

Onsite regeneration of the vapor phase carbon (using stream stripping of the carbon and condensation of the recovered waste product) was considered as a method of reducing system operating costs. A present value comparison of onsite and off-site regeneration of the vapor phase carbon revealed that the payback period for the onsite system would be in excess of six years. This alternate method of regenerating the vapor phase carbon has not been recommended at this point because of relatively high capital investment required, remaining uncertainties surrounding the selection of a Final Groundwater Remedy, and the possibility that dissolved contaminant concentrations could decrease over time. Additionally, by stripping the benzene fraction from the carbon and storing it as a liquid onsite, the potential for creating an explosive atmosphere within the treatment building would be increased. If it is determined that the Final Remedy will include the treatment system specified herein and groundwater contaminant concentrations stay at or near their current levels, onsite regeneration should be considered for incorporation into the treatment scheme to reduce the system's life-cycle costs. Because the onsite carbon adsorption/regeneration system has a similar size footprint to the vapor-phase carbon vessels specified herein, a substitution could be made at a later date with relatively low incremental costs.

As mentioned above, the data gathering effort continues at the SCD Site. The results of this process could identify additional design needs for the treatment system. Finally, because this treatment system design is based on estimates of permit limits, it might require further modification to achieve discharge and/or air permit compliance.

3.3.4 Treatment Building

A treatment building will be installed at the site and will be sized to house the treatment system described. It is expected that a 50 ft by 50 ft building footprint will be required. To ensure ease of installation and maintenance, an insulated steel wall building (Butler or equivalent) will be constructed on a concrete slab foundation at the site. The building will be placed to the south of the existing sedimentation basin at a location that is expected to be relatively free of surface soil contamination and is generally level. This placement location (See drawing C1-1) was selected to minimize the overall system construction cost (including road installation, site preparation, and conveyance piping costs) and to reduce the impact of construction and system operation on the other remedial activities being carried out at the site.

3.3.5 Conveyance Systems

Subsurface pipe installation will be constructed from extraction wells to the treatment building and from the treatment building to the discharge location. Pipe trenches will be approximately 3 ft to 4 ft deep with sand/fine gravel pipe bedding. The remaining backfill can be material previously excavated to form the trench. Backfill should be compacted to 95% of standard proctor densities. Various diameter (ranging from 2 inches where the flow is the lowest to 3 inches where combined flows would increase friction losses) AISI 316 stainless steel pipe will be used from the extraction wells to the treatment building. Conveyance pipe diameters were determined by balancing the increases in head loss due to friction against the higher costs of larger diameter piping. Allowance for the potential addition of more extraction wells was also taken into account when sizing conveyance piping. Additionally, a sealed Y-junction will be installed at locations adjacent to each extraction well vault to allow for the potential addition of extra pipe runs (if additional extraction wells are needed). Within the treatment plant, primarily 3-inch AISI 316 stainless steel piping will be employed. Sizing of the treatment plant piping was done to allow expansion of plant capacity without the need to replace piping. As with well construction materials, AISI 316 stainless steel (which is approximately 30% more expensive but is more resistant to attack by chlorides) is specified because of the elevated groundwater chloride levels observed during the RI/FS sampling. The decision not to use polyvinyl chloride (PVC) or other plastics for these lines was made because of serious concerns about the ability of plastics to resist degradation by the chlorinated benzene compounds present in the groundwater. Teflon® piping was considered along with the other plastics, but it was rejected because of its extremely high costs. Carbon steel piping was rejected because of concerns about the corrosive effects of low pH groundwater and high chlorides present at the site. Single wall piping will be used because double wall stainless steel piping was not deemed to provide sufficient benefit within the containment barrier wall to justify the substantial cost increase.

Because compatibility issues are not expected to be a problem with the treated water, it is expected that a 4-inch PVC pipe will be used for the discharge line running from the treatment building to an energy dissipation feature (such as a reno mattress) that will be constructed at the outfall in the eastern sedimentation/stormwater capture pond being constructed as part of this remedy. The water discharged from this pond will flow overland to the banks of the Red Lion Creek.

The extraction piping trench will also contain the power and control wiring for the extraction pumps.

Pipe sizing calculations on which the piping choices were made are included in Appendix G.

3.3.6 Product Recovery

Although the majority of DNAPL observed at the SCD Site has been found in quantities too small to allow cost-effective removal, certain existing wells show potential for periodic, or pulsed, DNAPL recovery. Wells in which DNAPL has previously been found will be selected for recovery. These wells include TW-30, RW-2, RW-5, and MW-28. Unfortunately, it is anticipated that wells MW-28 and RW-5 will need to be demolished during the installation of the containment barrier wall. Following completion of barrier wall construction in the area of these two wells, new monitoring wells (PMW-41 and PMW-42, respectively) will be installed nearby, and recovery will be attempted. It is also possible that additional recovery attempts will be made at MW-3, MW-6, or other locations as further information about the presence of DNAPL becomes available. Recovery will be accomplished using low volume bladder pumps operated periodically with recovered product collected in drums to be placed at the wells. The drums will be stored on temporary secondary containment structures within the treatment building until they can be shipped off-site for disposal.

3.3.7 Containment Barrier Wall

To prevent the contaminated groundwater underlying the SCD Site from reaching the Red Lion Creek, a circumferential soil-bentonite slurry wall will be installed around the entirety of the plant area and a portion of the wooded area north of the facility fence line. This containment barrier wall will be approximately 2 to 4 feet thick and will be keyed into the clay layer separating the Columbia and Potomac formations. A soil cap will be installed over the barrier wall to preserve its integrity and structural pass-throughs will be added to allow vehicle traffic to cross at specified locations. In developing the design of the containment barrier wall, constructability was taken into account along with the results of the groundwater model for the site. Compatibility testing is ongoing to confirm that excavated materials from the site can effectively be used as backfill for the barrier wall. A more detailed discussion of the containment barrier wall is presented in the Containment Barrier Design Report included as Appendix B.

Approximately 11 monitoring wells and 30 piezometers will be installed at various locations on the immediate inside and outside of the barrier wall. These wells – in addition to certain existing wells located just inside and outside the projected barrier wall alignment and along the southern edge of the Red Lion Creek – will be used to monitor head differential across the containment barrier wall and contaminant concentration trends outside the containment system. Additionally, 27 of the existing monitor wells and four former extraction wells at the site will be abandoned during construction of the barrier wall. Those wells observed to be in poor condition, those located along the alignment of the barrier wall, and those that do not add significant added information when sampled (i.e., located in a cluster within the barrier wall) were selected for abandonment. Anticipated well and piezometer placement locations are presented along with those wells initially planned for abandonment on Drawing C2-7 in Appendix E. A list of those wells slated for abandonment is presented in Table 3-2.

A concept level discussion of various cap alternatives is included in the Containment Barrier Design Report (Appendix B). Installation of a cap over the 15 acres of the Site that lie within the proposed barrier wall alignment and north of the facility fence line would reduce rainfall infiltration and therefore treatment volume and O&M costs. Generally, the concept level analysis shows that O&M savings could be realized if a cap were installed in this area. The analysis (included as part of Appendix B) also shows that a geomembrane cap option presented the quickest payback period.

3.3.8 Addressing Contamination Remaining Outside the Barrier Wall

Because of constructability issues it was decided (after consultation with EPA and DNREC) that capturing all of the groundwater contamination within the containment barrier wall would not be feasible. Therefore another method(s) of dealing with the remaining contamination was needed.

As an initial approach, the use of extraction wells to hydraulically contain contamination located to the north of the barrier wall was investigated. An alternative including two such extraction wells was included in the revised groundwater model (included in Appendix A). While the model did show that containment of the contaminated groundwater would be improved by using this approach, it apparently would not completely contain the contamination. Additionally, this method (as modeled) would more than double the volume of water requiring treatment and would substantially increase operating costs.

In-situ chemical oxidation (ISCO) is also being investigated, and bench-scale testing has indicated that the use of Fenton's Reagent or persulfate would likely be successful in addressing subsurface contamination. It remains to be seen (in future pilot testing) whether ISCO can be applied cost-effective at the SCD Site. Details on the bench testing procedure and results are presented in Appendix H.

In-situ thermal processes were also researched, but these were discounted after discussions with multiple vendors indicated that it was unlikely that this technology would be able to achieve effective treatment. Similarly the use of oxygen producing compounds and hydrogen producing compounds to accelerate bioremediation processes was discounted after vendors indicated that they would not be cost-effective in dealing with the site-specific contaminants.

Remediation using bimetallic nanoparticles was also investigated but was eliminated after determining that this method would most likely degrade the existing chlorobenzene contamination into more toxic benzene. In addition, this technology would be dependent upon effective subsurface dispersion of the nanoparticles.

Pilot-scale research of ISCO will be performed to determine whether the approach can be cost-effectively applied at the Site. If it is determined that ISCO can not be cost-effectively applied, it is expected that additional extraction wells will be added to the north of the barrier wall. Many components of the treatment system are modular so that they can be expanded to handle additional flow as necessary.

3.4 System Testing and Startup

Upon completion of construction of all components, a two-month long system startup and testing period is anticipated. It will consist of the following:

- 5 days (8 hours/day) of closed loop operation of the system that is staffed for the entire duration. Potable water will be run through the system in a closed loop to work out any major system flaws.
- Next, groundwater would be pumped from the extraction well and sent through the treatment system. The treated groundwater will be discharged into temporary, onsite storage tanks (Baker/Frac tanks) for daily analytical testing. Treated groundwater will be discharged into the discharge points once testing results indicate the water meets the appropriate NPDES discharge limits/surface water criteria. It is anticipated that the system will be operated in this fashion for 5 days (8 hours/day) and require staffing for the entire duration.
- Upon successful completion of the above step, the treatment system will be operated for 8 hours/day for 5 days by pumping groundwater from the extraction wells for treatment and direct discharge of the treated water into the proposed Red Lion Creek discharge line. Daily sampling will be performed to assure that the treated water meets the appropriate NPDES discharge limits/surface water criteria.
- Then the treatment system will be operated for 24 hours/day for 10 days by pumping groundwater from the extraction wells for treatment and direct discharge of the treated water through the proposed Red Lion Creek discharge line. Daily sampling will be performed to assure the treated water meets the appropriate NPDES discharge limits/surface water criteria.
- Air emissions from the subject system will be monitored throughout the startup procedure to ensure compliance with all air quality/air permit requirements.
- During the 10 days that groundwater is pumped from the extraction wells on a 24 hour/day basis, as well as the 20 days following successful startup, data loggers will be placed in seven pairs of monitoring wells to monitor drawdown from the system, changes in head differential across the barrier wall, and the barrier's

impacts on groundwater flow patterns.

All NPDES and air permit related sampling will be conducted by BVSPC personnel with assistance from RA construction contractor personnel.

3.5 Treatment System Performance Monitoring

Upon successful startup of the system described above, it is anticipated that the remediation subcontractor will be responsible for operations and maintenance of the system for one year, although the actual duration of the initial O&M period might be extended if requested by the EPA and DNREC. All NPDES, groundwater, surface water, and air permit related sampling will be conducted by BVSPC personnel with assistance from RA construction contractor personnel. System performance criteria will be established that include permit compliance, inspection and maintenance schedules, and minimum system run times.

The ROD contains requirements for the monitoring of the groundwater containment and extraction systems. Long term monitoring of the site in accordance with the terms of an EPA and DNREC approved Operation and Maintenance (O&M) Plan is anticipated for between 15 and 30 years. The actual duration and frequency of the monitoring – along with the specific contaminants to be monitored – will be determined as part of the Final Groundwater Remedy that is yet to be developed. Currently, it is anticipated that groundwater elevations will be obtained monthly over the course of the first year of operation and quarterly thereafter. Current plans also call for quarterly groundwater quality sampling during the first three years of operation and semiannual sampling thereafter. The formal O&M Plan has not been developed as of yet and is not included as a component of this task of the RD.

It should be noted that the 15 to 30 year term is a standard engineering project lifespan that was used in the choice of materials for piping and treatment system equipment. While certain less expensive materials were available for these parts, they were not selected because we determined that they would not have sufficient lifespan to provide effective long-term treatment. Aside from the added capital cost of the selected materials, the 15 to 30 year term did not impact project cost estimates because the M-CACES cost estimating package does not permit depreciation costs for equipment.

Groundwater quality sampling will occur quarterly for three years following system startup and semiannually thereafter (unless otherwise dictated by EPA and DNREC). Because a lowering of the Columbia Aquifer water level is desired to reduce/prevent the potential spread of site contaminants down into the Potomac Aquifer, water level checks will be performed regularly on paired monitoring wells (located across the barrier wall from each other). With each water quality monitoring event the piezometric surface will be determined using all Columbia monitoring wells and piezometers. In addition, the piezometric surface will be determined at two additional times during the year, one during the wet season and one during the dry season for a total of six gauging events per year during the first three years. Potomac Aquifer wells will also be sampled, and water levels taken, to determine the impact of the implemented remedy on the aquifer's water quality. To ensure that sufficient coverage is obtained, additional monitoring wells will be installed along the interior and exterior of the containment barrier wall. Samples will also be collected periodically from existing monitoring wells located to the south and north of Red Lion Creek. Because of the anticipated reduction in groundwater flow to the wetlands surrounding the Red Lion Creek and its unnamed tributary, additional monitoring of downgradient groundwater levels and wetlands conditions might also be required.

In addition, surface water and sediment samples will be collected from the Red Lion Creek and its unnamed tributary. Finally, samples will be collected from the influent, effluent, and at key points of the treatment system.

All samples will be analyzed for target contaminant list (TCL) organics, additional site-related contaminants and degradation products, and target analyte list (TAL) metals.

The data from these activities will be reviewed as a whole to gain an overall picture of plume containment. The water level and water quality data will then be used to identify any additional measures that might be required to improve plume capture. Extraction well flow rates will be measured and combined with the remaining data to evaluate the overall effectiveness of the remedy and identify any unforeseen impacts of the containment system.

Based on the water budget performed by Conestoga Rovers Associates as part of the PRP's RD efforts (CRA, 2001), it is not anticipated that the installation of the circumferential barrier wall and groundwater extraction system will have a substantial hydraulic impact of the wetlands surrounding Red Lion Creek. On a long term basis, the flow being removed by the containment barrier wall and treatment system is relatively minor compared to the total flow through the wetlands and Red Lion Creek. Additionally, the containment of upgradient contaminated source areas will improve the overall quality of groundwater entering the wetlands.

The O&M plan will also have provisions to ensure monitor and extraction wells remain in functional condition. At this time, well condition monitoring is anticipated to include visual inspection of the well cap and above-ground portion of the casing, noting of any obstructions encountered during sampling, and periodic (approximately once every two to three years) down well video inspection of the well. Condition reports will be generated periodically for all monitoring wells located at the Site.

4.0 Design Criteria

4.1 Introduction

The following sections outline design criteria for major components of the groundwater containment barrier wall and groundwater extraction and treatment system discussed in Section 3.3. The design criteria for the containment barrier wall and extraction wells are based primarily on the ROD goals for groundwater, but the discharge requirements anticipated for the treated groundwater and air emissions will govern the treatment system process design.

4.2 Groundwater Cleanup Standards

The ROD for the SCD Site established the Groundwater Remedial Objectives as described in Section 3.1. However, the ROD further states that restoration of the entire contaminated portion of the aquifer associated with the SCD Site to drinking water standards might not be "technically practicable" under the Interim Remedy for the site. The ROD also does not establish specific groundwater cleanup limits for the Interim Remedy, leaving those to be developed in the Final Remedy for the site. Whereas the objectives of preventing contaminant migration and eliminating exposure to contaminated groundwater will be taken into account in the design of the extraction and barrier wall systems, the anticipated air and water discharge criteria are used as the primary treatment system design criteria.

Based on the results of DNAPL investigations conducted as part of BVSPC's RDI and the PRP's earlier RDI, it appears that there is no one concentrated pool of DNAPL. Instead, it appears that much of the DNAPL is spread across the contaminated area and consists largely of small globules adhering to the soils underlying the Site. As a result, DNAPL recovery will be limited to periodic (or pulsed) recovery using low volume bladder pumps temporarily installed in wells where DNAPL has previously been identified. Based on discussions with Mike Towle of the EPA's ERT, it is anticipated that DNAPL recovery activities will occur approximately twice per year. This frequency may be adjusted based on the results of the first year's recovery efforts. These wells include TW-30, RW-2, RW-5, and MW-28. Because it is expected that construction of the containment barrier wall and the associated work platform will necessitate the demolition of RW-5 and MW-28, new wells will be installed in adjacent areas to address the identified DNAPL.

4.3 Treatment Standards for Discharge to Surface Water

Based on concerns expressed by EPA and the evidence of historical contamination related to the facility's existing WWTP discharge line, an alternative discharge line (including energy dissipation feature) will be constructed. The treated water will ultimately flow to the Red Lion Creek. This discharge will be required to meet the substantive requirements of the NPDES, under which maximum discharge limits will be set for each specific parameter. To estimate potential Red Lion Creek discharge limits for each of the site COCs, BVSPC has used the most stringent of the MCLs, Delaware's Water Quality Criteria, and the Delaware River Basin Commission Freshwater Objectives. The facility's existing NPDES permit limits (as presented in the PRP's RDI) were also reviewed and are listed in Appendix H, but because there will be a new receiving body and a new treatment system, these limits are not expected to be relevant. The relevant limits from the remaining three sources are shown in Table 3-1. The final NPDES discharge limits for the Red Lion Creek discharge will not be available until a final determination is made by DNREC and the EPA.

There was a general lack of historical metals and hardness data for the groundwater at the SCD Site. Consequently, a review of data for eight samples collected from the four Oxychem wells located closest to the SCD Site was performed as part of the RD process. This data shows that the metals concentrations were typically less than their respective MCLs and the levels listed for SCD's NPDES permit. The exceptions to this were for copper (which was detected in the blank for the samples), mercury (likely the result of Oxychem specific activities), zinc (in one sample), and thallium (slight exceedances in two samples and detected in the blank for three others). These data are included in Appendix H. In addition, BVSPC collected groundwater samples and had the samples analyzed for metals content as part of the ongoing facility RI/FS. The data from these samples showed that concentrations of aluminum, iron, manganese, copper, and zinc were higher than at least one of the limits considered in development of the projected treatment system discharge limits. Based on this information, a metals removal process was added to the treatment system. Because of the hardness levels present in the sampled groundwater and the formula for the Delaware Water Quality copper criteria, the copper concentrations observed in the groundwater should not be an issue with regard to discharge limits.

4.4 Treatment Standards for Discharge to Air

It is currently anticipated that the treatment system will discharge treated off-gas from the air stripping operation to the atmosphere. Therefore, this discharge will be required to meet the substantive requirements of the Delaware Regulations Governing the Control of Air Pollution and the Delaware Ambient Air Quality Standards, which will govern the maximum contaminant levels for each specific parameter. The facility's existing air emission discharge limits for boiler number 3 (as presented in the PRP's RDI) are listed in Appendix H, but because of the cessation of manufacturing activities at the site, these are not expected to be relevant. In conversations with Delaware's Air Quality Management Section, it was suggested that 0.1 lb/hr of VOCs is sometimes used as a discharge limit for Superfund sites in Delaware. While it was subsequently determined that this value has been largely used for soil vapor extraction systems, the treatment scheme in this design is intended to limit VOC discharges to less than 0.1 lb/hr. The final discharge limit will be determined by DNREC (likely after consultation with the EPA).

4.5 Treatment Process

Contaminated groundwater will be pumped from the extraction wells to the treatment system via subsurface piping. The primary treatment processes to remove the contaminants from the groundwater will be air stripping with carbon adsorption polishing. Along with air stripping and carbon adsorption, solids removal (using bag filters will be employed to minimize clogging of the air stripper and carbon units. Based on drinking water standards, Delaware Water Quality standards, and aquatic toxicity data, a metals removal step (in the form of pH adjustment and a green sand filter) will be necessary to reduce concentrations of iron, manganese, and aluminum prior to discharge. Depending on the limits implemented by DNREC for copper and zinc, it might also be necessary to add an ion exchange step immediately before discharge. Depending on the observed operation of the system, a DNAPL removal step (in the form of a settling tank separate from the influent storage tank) might also be necessary to prevent clogging in the air stripper. To determine whether fouling due to hardness would be a problem in the air stripper, the Langelier Saturation Index (LSI) was calculated for the Site groundwater using an average of data for samples collected from wells located within and adjacent to the projected barrier wall alignment. While the hardness is elevated for the groundwater, the LSI was determined to be -2.9 which indicates a corrosive water (as would be expected given the groundwater's low pH). LSI Calculations are included in Appendix G. Although the aeration of the water resulting from the air stripper will raise the pH somewhat, fouling is not expected to be a serious problem. Nevertheless, a tray type stripper made using AISI 316 stainless (to avoid corrosion problems) will be employed to minimize labor required for any fouling. The treated water will be discharged into the eastern stormwater basin, from which it will gravity flow through the basin's discharge pipe, and travel overland to the Red Lion Creek wetlands located to the north of the Site. For the treatment of the air discharge from the stripper, vapor phase granular activated carbon units (equipped with a duct heater) will be utilized.

The process and associated treatment components indicated above are readily available and will appropriately meet the needs for this project. Therefore, detailed component design criteria for a treatment system have only been established for certain portions of the system. Overall performance criteria have been also been developed and must be adhered to. The 100 percent design treatment system performance criteria are:

- An initial average 43 gpm flow from the extraction, conveyance, and discharge systems described above will be treated onsite to achieve the applicable discharge criteria. This flow rate allows for drawdown of the water level within the barrier wall to equalize the gradient between the Potomac Aquifer and the Columbia Aquifer over the course of approximately three years. Following equalization of the gradient between the two aquifers, extraction and treatment rate will be reduced to approximately 18 gpm to offset infiltration and maintain the gradient. Note that the treatment system equipment was designed in a modular fashion to handle up to 95 gpm, thereby allowing it to handle the potential added volume from wells that might be installed to capture contamination remaining outside the northern end of the barrier wall. The 43 and 95 gpm rates were also used when sizing pumps, conveyance piping, and process piping. When the system is scaled back to 18 gpm, it may be advisable to change out the process pumps in the system for pumps that can operate more efficiently at that lower rate.

- The treatment system influent contaminant concentrations are based upon data collected from those onsite wells for which recent water quality data is available. In determining the influent concentrations, only those wells that lie within or immediately outside the proposed barrier wall alignment were considered. Those wells that would be located outside the barrier wall were excluded because it is not expected that water from these wells will enter the treatment system. To ensure that the designed system is capable of treating extracted groundwater to the projected discharge limits without over sizing the system components, both average and maximum contaminant levels were considered when sizing the proposed treatment system. To ensure a conservative estimate of groundwater quality, safety factors 30% were applied to the contaminant concentrations. These concentrations were then compared to the current facility NPDES limits, MCLs, DRBC Stream Quality Objectives, and DE Specific Water Quality Criteria to identify which contaminants would most likely be regulated in the treatment plants discharge and what limits would be set for these contaminants. Water quality and flow data as well as average and maximum COCs and metals concentrations used in the design criteria are presented in Table 4-1.

- Performance will be monitored and evaluated based on periodic sampling and analysis of surface water, monitoring wells and the treatment system influent/effluent streams. A monitoring and evaluation program to be implemented after system startup will include quarterly sampling and analysis of the treatment system's influent and effluent. This sampling will be performed in addition to any sampling that may be required to meet the substantive requirements of the NPDES permit. Trend analyses will be performed on the compiled analytical data to track the remediation progress.

- Additional system specific design will be required by the successful subcontract bidder. During the bidding, bid evaluation, and pre-construction timeframes, the successful bidder will provide sufficient detail to demonstrate the adequacy of the proposed system design in meeting the project objectives.

4.6 Containment Barrier Wall

A circumferential soil bentonite slurry wall will be constructed around the majority of the Site to contain the contaminated groundwater plume underlying the SCD facility and prevent the plume's migration to the Red Lion Creek and its unnamed tributary. Initially a cutoff barrier wall was proposed to capture the groundwater plume, but after discussions with state and EPA officials, the design was changed to use the circumferential alternative so that operations and maintenance costs related to the groundwater treatment plant would be minimized. A three-dimensional groundwater model was developed and run to assist in the design of the revised circumferential barrier wall and pumping scheme. Data from geotechnical investigations and a cone penetrometer testing (CPT) study of the barrier wall alignment have been used to used to refine the barrier wall design and delineate (to the extent possible given site restrictions) the clay layer between the Potomac and Columbia aquifers. To ensure that the barrier wall is effective, the following criteria were also used in its preliminary design:

- Dimensions – The barrier wall will be approximately 5,300 feet long and will encircle the upland portions of the Site property. To ensure that groundwater flow is sufficiently impeded, the barrier wall will be approximately 2 to 4 feet thick. To minimize/eliminate the possibility of groundwater bypassing the barrier wall by flowing under it, the barrier wall will average approximately 70 feet in depth and will be keyed (to a depth of approximately three feet) into the clay layer separating the Potomac and Columbia formations.

- Barrier Wall Life – Although the actual project life will be determined later in discussions with DNREC and EPA, the barrier wall is being designed at this time to have a minimum effective life of 30 years. 30 years was selected as a standard civil engineering design lifespan that should be appropriate as a minimum lifespan.

- Operations and Maintenance – The barrier wall is being designed for minimum O&M.

- Alignment – The barrier wall will be placed so as to contain the bulk of the site's contaminated groundwater on the site property and prevent its flow to the Red Lion Creek and its unnamed tributary. To accomplish this, the barrier wall will encircle the Site's upland area from Governor Lea Road to a line approximately half way between the sedimentation basin and Red Lion Creek. The proposed alignment of the barrier wall is presented graphically on Drawing C2-6 in Appendix E.

- Permeability – Testing of the proposed soil bentonite mixture will be required to ensure that an installed permeability of less than 1×10^{-7} cm/sec is achieved. Permeability testing of material from the projected key-in layer has shown that the average permeability of the collected samples is approximately 6.7×10^{-8} cm/sec. To test compatibility of the wall with the surrounding soils, permeability tests are being performed using combinations of material from a highly contaminated RI boring, a likely bentonite source, and contaminated groundwater collected from various monitor wells located at the site.

- Constructability – The barrier wall is being designed to allow the use of conventional construction means and methods. Although the ROD specifies that the barrier wall is to be constructed along the shoreline of the unnamed tributary and Red Lion Creek, the steep slopes present along the eastern edge of the unnamed tributary would make construction of the barrier wall difficult and could pose structural problems for a barrier wall of this type. Consequently, this design proposes to move the western leg of the barrier up the slope to more level ground. Additionally, geotechnical borings installed along the southern edge of the Red Lion Creek wetland showed that the materials present at the projected key-in depth were of a higher permeability type than that required for the construction of an effective containment barrier wall. Because of this and the presence of high groundwater levels in that area, the northern leg of the barrier has been moved up the slope away from the Red Lion Creek wetlands. These moves were incorporated following consultation with the responsible DNREC and EPA officials. Unless prohibited by EPA or DNREC, trench spoils will be used as backfill for the barrier construction. It is anticipated that, based on results from the RI NESB sampling, only a portion of the soils from the western section (Sections G-G1 and G1-G2) of the barrier alignment will be unsuitable for use as backfill material. Those materials that are found to be unsuitable will be placed in the temporary staging area (to be constructed to the north of the sedimentation basin) for subsequent treatment and disposal during the soil and sediment portion of the RA.

- Soil Staging – In addition to the contaminated trench spoils, the staging area will contain the two existing contaminated soil piles that are currently located to the north of the facility fence line. These piles must be moved to allow the construction of the barrier wall. The staging area will be constructed with a polyurethane coated geotextile (or other compatible material) base and a cover made of XR-5 or similar geotextile. The polyurethane was selected for the base material because of its expected higher compatibility with the contaminants in question. XR-5 (or equivalent) is expected to be acceptable for the top cover because although it provides somewhat lesser chemical resistance, it will be open to inspection, patching, and/or replacement. It is also approximately one third of the cost of the polyurethane material.

A more complete discussion of the barrier wall design including stormwater management plan for the construction of the barrier wall and treatment system is presented in the Containment Barrier Design Report which is included as Appendix B.

4.7 Treatment Building

The treatment system building at the site will be a pre-engineered building constructed of insulated steel on a concrete slab foundation. No windows will be installed on the buildings for security reasons. It is anticipated that the treatment building will be approximately 50 ft X 50 ft with an approximately 16 ft high ceiling to comfortably accommodate the expected treatment equipment and any possible hazardous materials required or hazardous waste generated in the treatment process. Heating and ventilation will be provided to maintain a minimum air temperature of 55 ^oF and a maximum air temperature of 100 ^oF in the building. Floor drains, secondary containment, and a sump will be incorporated into the slab construction to minimize the potential for spreading contamination in the event of a piping or tank failure.

Specific design performance criteria for the building's civil/structural, mechanical, and electrical items are included in the respective specifications. The building and all appurtenances will be required to conform to the BOCA 99 Code and the National Electrical Code, along with all local and state building codes.

4.8 Well Standards

Six groundwater extraction wells (EW-1 through EW-6) for the extraction of contaminated groundwater will be constructed in accordance with appropriate DNREC requirements. The wells are designed for the extraction of captured contaminated groundwater from the bottom of the Columbia Aquifer. Based on the available historical data and the groundwater capture model that is included as Appendix A, initial pumping rates for each extraction well are estimated to be between 7 and 10 gpm. This pumping scheme should result in a lowering of the Columbia Formation water levels within the barrier wall and reduce/eliminate any migration of site-related contamination from the Columbia Aquifer down into the Potomac Aquifer. Once the downward gradient between the two aquifers is eliminated, the pumping rates will be reduced (to approximately 3 gpm for each extraction well) to maintain the hydraulic equilibrium. Although a versatile submersible pump has been specified as part of this design in hopes of avoiding pump replacement once the desired Columbia draw down is achieved, it might be necessary to utilize lower flow pumps to achieve the reduced head maintenance flow after the downward gradient is eliminated. Initial pumping rates will ultimately be based in part on yields that can be obtained during pump tests conducted as part of actual well construction/development during the RA implementation. Extraction wells will be operated continuously, but they will be equipped with water level controls so that an optimum drawdown is maintained at each extraction location and across the Site. Calculations regarding extraction well filter pack and well screen selection are included in Appendix G.

Eleven new monitoring wells (PMW-41 through PMW-51) will be installed at various locations along the inside and outside of the barrier wall to allow monitoring of groundwater levels and quality. In addition, 30 piezometers (PZ-1 through PZ-30) will be installed at the Site to monitor groundwater levels. These include one piezometer adjacent to each extraction well, and 24 located along the barrier alignment. Data obtained from the monitor wells and piezometers will be used to monitor the remedy's effectiveness with respect to maintaining the desired hydraulic gradients (vertical and across the barrier wall) and containing the contaminant plume. Monitoring wells and piezometers will be designed and constructed in accordance with the applicable DNREC standards. All wells will be designed and drawings sealed by a Licensed Geologist or Professional Engineer. Wells will be constructed by a Delaware certified well subcontractor under the supervision of a Licensed Geologist.

To address compatibility issues related to chlorinated benzenes, high groundwater chloride concentrations, and the low pH of the groundwater, all wells and piezometers will be AISI 316 stainless steel, and only chemically resistant materials such as FEP, PVDF, Teflon®, and AISI 316 stainless steel will be used in the construction of all wells and any associated pumps.

In addition to the new wells and piezometers being installed, 27 existing wells will be abandoned as part of the RA construction activities. Although the bulk of these wells are being eliminated because their locations interfere with barrier wall construction activities, others will be abandoned because they are redundant or in poor condition.

Well locations are presented graphically on Drawing C1-2 in Appendix E.

4.9 Conveyance Systems

Piping will be required between the extraction wells and treatment system, the treatment system and discharge point, and for potable water from a point of connection to the treatment system. Piping designs will comply with local building codes. To minimize construction costs, an effort was made to utilize the minimum diameter piping that would still allow efficient operation of the system. Piping selection has also taken into account anticipated subsurface and loading conditions as discussed in Section 3.3.5. AISI 316 stainless steel piping will be used for all contaminated groundwater conveyance. PVC will be used for transmission of treated water from the treatment system to the discharge point outside of the barrier wall (the treated water will flow overland to the Red Lion Creek wetlands from there). Wrapped carbon steel will be used for potable water transmission lines. These materials were selected to ensure that structural integrity and pipe functionality are maintained throughout the project lifetime.

4.10 Site Development, Land Acquisition and Easement Requirements

For the preliminary design, topographic surveys were obtained for the SCD Site. The resulting base map has been incorporated into the attached site plans that are presented in Appendix E.

Site development activities associated with this construction consist of the construction of a 50' x 50' treatment building, construction of a work platform and access roads for the barrier wall construction, construction of access roads and parking areas for the treatment building, trenching for installation of conveyance piping and utilities, and temporary drainage facilities. In addition to the construction activities, land acquisition and utility easements may be necessary.

During the construction of the barrier wall, it is possible that easements (or access agreements) may need to be secured from the neighboring Oxychem and Air Products properties. These agreements will be needed for the placement and sampling of monitor wells and piezometers that will be used to assess the effectiveness of the barrier wall.

The barrier wall has been designed, in part, to minimize or eliminate disruptions to local utilities and minimize construction impacts on surrounding businesses and residents. If it is subsequently determined that functioning utilities must be interrupted or relocated, BVSPC will work with the utility owner to minimize any effects to their clients. In the event that utility easements are required, it will be necessary to acquire all permits and follow all procedures as outlined in the County of New Castle Code Enforcement Manual and the Unified Development Code.

A large portion of the area where the barrier wall and treatment building are to be constructed is wooded. Parts of these areas will require clearing and regrading prior to construction. The access roads located to the north of the facility fence line will need to be upgraded to handle construction traffic. This upgrade will include, but not be limited to, subbase preparation for construction traffic, the development of an adequate surface course and the design of temporary stormwater management facilities. Trenching will be required to install conveyance piping from the wells to the treatment building and from the treatment system to the discharge point on the banks of the Red Lion Creek. To minimize the length of discharge piping and address concerns regarding the impact of site contamination on construction activities, the treatment system building will be located in an undeveloped portion of the area to the north of the facility fence line. This location will also minimize the effect of construction activities on facility remedial operations. Utilities, including potable water and electricity, will be routed to the treatment building and extraction wells from existing facility connections.

Demolition of various structures located near the southern perimeter of the site will be required to complete construction of the barrier wall. Demolition of the following structures/features will be required:

- The laboratory and office building at the southwest corner of the site;
- Portions of a tank farm located in the southeastern corner of the site;
- Portions of the railroad tracks located along the western edge of the site;
- Approximately 1,800 feet of fencing along the southern and western sides of the site;
- The facility electrical substation in the southeast corner of the site; and
- Approximately 27 monitor and recovery wells.

Additional areas that might be impacted during the construction of the barrier include:

- The facility cooling tower at the south end of the site;
- Two boiler buildings located at the south end of the site;
- Two areas of piping and tanks located along the southern border of the site;
- Other structures subsequently determined to interfere with RA activities.

Areas slated for demolition are depicted on Drawing C2-4 which is included as part of Appendix E of this document. A summary of the potentially impacted surrounding property owners is provided in Table 4-2 along with the property location, description of easement, and the affected properties' tax parcel numbers.

5.0 Basis of Design

5.1 Appropriate and Relevant or Applicable Requirements (ARARs)

The Remedial Action Contract Scope of Work under which this report has been prepared requires a detailed statement of how all applicable or relevant and appropriate regulations (ARARs) and federal and state public health and safety environmental requirements and standards will be met. This section provides summaries of the key ARARs and how the design will meet those requirements. A complete listing of all ARARs – as presented in the ROD – is included as Appendix I of this report. The ARARs also are an integral part of the Design Assumptions and Permitting described in Sections 5.2 and 5.6 below.

Section 121(d)(2)(A) of CERCLA incorporates into law the CERCLA Compliance Policy that specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be legally ARARs. In addition, any promulgated state regulation, standard, criteria, or limitation that is more stringent than the corresponding federal regulation, standard, criteria, or limitation must be adhered to during the remedial action for the SCD Site. The federal statutes that are applicable to the SCD Site include the following:

- Clean Air Act (CAA),
- Clean Water Act (CWA),
- Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments (HSWA),
- Protection of Floodplains,
- Protection of Wetlands,
- Coastal Zone Management Act and Coastal Zone Act Reauthorization Amendments,
- Archaeological and Historical Preservation Act of 1974, and
- Safe Drinking Water Act (SDWA).

Applicable state statutes for the SCD Site include the following:

- Delaware Regulations Governing the Control of Water Pollution,
- Delaware Water Quality Standards,

- Delaware Regulations Governing the Construction of Water Wells,
- Delaware Regulations Governing the Allocation of Water,
- Delaware Regulations Governing Public Drinking Water Systems,
- Delaware Ambient Air Quality Standards,
- Delaware Coastal Zone Act,
- Delaware Wetlands Regulations,
- Delaware Regulations Governing the Use of Subaqueous Lands,
- Delaware Regulations Governing the Control of Air Pollution,
- Delaware Regulations Governing Solid Waste,
- Delaware Regulations Governing Hazardous Substance Cleanup,
- Delaware Sediment and Stormwater Management Regulations Ambient Air Quality Standards, and
- Delaware Regulations Governing Hazardous Waste (DRGHW).

ARARs can be chemical specific, location specific, or action specific. ARARs for the SCD Site were reviewed and updated as part of the ROD and RD process and are considered during the RD. The following sections present summaries (taken in part from the ROD) of the federal and state ARARs that apply to the SCD Site for the RD.

5.1.1 Chemical-specific ARARs

Chemical specific ARARs are usually health or risk based numerical values limiting the amount or concentration of a chemical that may be found in, or discharged to, the environment. Chemical specific ARARs mandate that contamination levels found in site groundwater meet certain criteria to protect human health and the environment. Chemicals of concern at the site include chlorinated benzene compounds, benzene, toluene, and nitrobenzene. All of the ARARs provide some specific guidance on "acceptable" or "permissible" concentrations of contaminants in water. The following are the chemical-specific ARARs that apply to the SCD Site and have been considered as part of this design:

The Clean Water Act sets water quality criteria at levels protective of human health and of aquatic life in streams, lakes, and rivers. The CWA criteria will be considered relevant and appropriate for this site and will be considered in determining the effectiveness of the Remedial Action.

The Clean Air Act passed in 1977 governs air emissions resulting from remedial actions at CERCLA sites. National Ambient Air Quality Standards (40 CFR Part 50) have been promulgated under the CAA for six criteria pollutants, including airborne particulates. No specific air quality standards for the contaminants of concern at the site have been promulgated. The associated Delaware Implementation Plans for the Attainment and Maintenance of National Ambient Air Quality Standards (40 CFR Section 52 420-460 Subpart I) codify Delaware's Implementation Plan for attaining these standards. To the extent that remedial actions undertaken at the site emit and regulate air contaminants, the CAA would be relevant.

The National Emissions Standards for Hazardous Air Pollutants (40 CFR part 61) promulgate standards for air emissions from specific sources. These standards will be considered relevant and appropriate for the emissions from the air stripper.

Similarly, the Delaware Ambient Air Quality Standards, which establish ambient air standards at the state level, are applicable to emissions from the air stripper included as part of this design. These standards will be considered in developing the criteria for the treatment of off-gas from the air stripper.

5.1.2 Location-specific ARARs

Location specific ARARs include restrictions on certain types of activities based onsite characteristics. Location-specific ARARs govern activities in critical environments such as wetlands, endangered or protected species habitats, and historic locations. BVSPC believes the current groundwater remedy, as specified in this design document, is compatible with a future restoration of tidal hydrology in the Red Lion Creek. Furthermore, the pending soil and sediment remedy will include provisions for restoration of the appropriate hydrology to the site wetlands, with a goal of restoring tidal hydrology.

<u>The Coastal Zone Management Act (16 USC Section 1451) and the Coastal Zone Act Reauthorization Amendments of 1990</u> require that any activities that directly affect the coastal zone and are conducted or supported by federal agencies be conducted in a manner that is consistent with the approved state coastal zone management program. Because the SCD Site is located in the Delaware coastal zone, both the Act and the related Amendments are applicable to the site. All Remedial Action activities will be performed – to the extent practicable – in a manner consistent with Delaware's coastal zone management program, and DNREC will be notified of EPA's determination that the activities are consistent to the extent practicable.

The Archaeological and Historical Preservation Act of 1974 (16 USC Section 469) outlines requirements to guard against the loss of significant scientific, historical, or archaeological data. This Act is considered applicable to the site and will therefore require that an effort be made to identify any potential resources that might be put at risk by the construction activities related to the Interim Groundwater Remedy. If any such resources are identified, steps will be taken to minimize the potential for any adverse impact.

The Protection of Floodplains (40 CFR Part 6, App. A) regulations codify the EPA policies for carrying out Executive Order 11988. These regulations require that activities within the 100 year floodplain be conducted in a manner that avoids adverse effects, minimizes potential harm, and restores and preserves the beneficial values of these areas.

Because a portion of the construction activities will take place in the 100 year floodplain, these regulations are applicable to this RD.

The Protection of Wetlands (40 CFR Part 6, App. A) regulations codify the EPA policies for carrying out Executive Order 11990. These regulations require that activities within wetlands be conducted in a manner that avoids adverse effects, minimizes potential harm, and restores and preserves the beneficial values of these areas.

Although the construction activities are not expected to infringe upon the wetlands, the containment system will affect the natural groundwater flow and the treatment system will discharge to the Red Lion Creek. This indicates that the Interim Remedial Action will alter the hydrology of the wetlands surrounding the Red Lion Creek and its unnamed tributary. For this reason, these regulations are applicable to this RD.

The Delaware Coastal Zone Act (7 Delaware Code Sections 7003-7004) controls the location, type, and extent of industrial activities in Delaware's coastal areas. These regulations are considered relevant and appropriate for the activities at the SCD Site. However, according to a DNREC publication entitled "Regulations Governing Delaware's Coastal Zone" (DNREC, 1999), the coastal zone "regulations specify the permitting requirements for existing non-conforming uses already in the coastal zone and for new manufacturing uses proposing to locate within Delaware's coastal zone." Because the remedy does not appear to fall under either of these classifications, it is uncertain whether the regulations of the Coastal Zone Act (CZA) would be applicable to the Site. After reviewing the permitting requirements listed in the CZA regulations, it appears that even if the CZA is applicable to this project, a coastal zone permit would not be required. Additional conversations will be conducted with the Coastal Zone Industrial Control Board to determine whether a "Request for Status" needs to be submitted for the project.

As discussed in Section 3.3.3, a review of the CZA revealed that the use of a thermal oxidizer or catalytic oxidizer to treat the off-gas from the air stripper included in this RD would likely be prohibited at the SCD Site. Because of this and potential technical issues related to the chlorine content of the waste that would be treated by the oxidizer, an alternative treatment technology was chosen.

The Delaware Wetlands Regulations require that activities that adversely affect wetlands be permitted and that such permits be approved by the county or municipality having jurisdiction over the location of the work. These regulations are applicable to the Interim Groundwater Remedy because of the aforementioned effects that the containment barrier wall will have on the wetlands hydrology. As stated in Table 10 of the ROD, because the RA activities will be completed onsite, no permit will be required in accordance with Section 121 of CERCLA. However, all substantive requirements of the regulations will be met. Because eight years have passed since the ROD was published, it might be advisable for the EPA to revisit this determination. In the event that it is subsequently decided that permits are required for these activities, BVSPC will complete the appropriate permit application process.

The Delaware Regulations Governing the Use of Subaqueous Lands require that activities that affect public or private subaqueous lands be permitted. These regulations are applicable to the Interim Groundwater Remedy because of the aforementioned effects that the containment barrier wall will have on the wetlands hydrology. As stated in Table 10 of the ROD, because the RA activities will be completed onsite, no permit will be required in accordance with Section 121 of CERCLA. However, all substantive requirements of the regulations will be met. In the event that it is subsequently decided that permits are required for these activities, BVSPC will complete the appropriate permit application process.

5.1.3 Action-specific ARARs

Action specific ARARs are usually technology or activity based directions or limitations that control actions taken at hazardous waste sites. Action specific ARARs are triggered by the types of actions under consideration. The following are the action-specific ARARs that apply to the SCD Site:

The Clean Water Act and National Pollution Discharge Elimination System (NPDES) Requirements (40 CFR Sections 122.2, 122.4, 122.5, 122.21, 122.26, 122.29, 122.41, 122.43-45, and 122.47-48) regulate the discharge of pollutants into navigable waters of the U.S. Because the groundwater treatment system will discharge treated groundwater into the Red Lion Creek the CWA and NPDES requirements are applicable to the SCD Site. The treated water will meet the limits set by DNREC and the EPA for a new outfall on the Red Lion Creek. Wastewater generated during decontamination activities performed as part of site construction activities shall be properly managed in accordance with DRGHW regulations and/or the CWA.

Although Table 10 of the ROD specifically states that no NPDES permit is required for a discharge from a new treatment system such as the one proposed here, the fact that eight years have elapsed since the ROD was published suggests that it might be advisable for EPA to revisit this determination. In the event a NPDES permit is required, BVSPC will complete the application process, and final discharge limits will be based on those listed in the NPDES permit.

The Delaware Regulations Governing the Control of Water Pollution govern point and non-point source discharges to Delaware waters. The rules include requirements for permits, permit applications, permit conditions, and monitoring. The rules are applicable for remedial actions involving a discharge to surface water (such as the proposed groundwater treatment system) as well as for stormwater runoff into the Red Lion Creek and its unnamed tributary.

Although Table 10 of the ROD specifically states that no NPDES permit is to be obtained for a discharge from a new treatment system such as the one proposed here, in the event a NPDES permit is required, BVSPC will complete the application process, and final discharge limits will be based on those listed in the NPDES permit.

The Delaware Regulations Governing the Construction of Water Wells establish requirements for the construction, location, repair, use, and abandonment of wells and pumping equipment. Construction of all new monitoring and extraction wells, and the abandonment of any existing wells will be performed in accordance with these regulations. BVSPC has discussed the proposed methods for abandoning existing wells and installing new wells at the site with members of DNREC's Division of Water Resources and have determined that these methods are acceptable.

The Delaware Regulations Governing the Allocation of Water cover the permitting of proposed groundwater extraction/recovery systems. These regulations are applicable to the extraction wells included in this project.

Table 10 of the ROD specifically states that no permit is required for the proposed groundwater extraction system, but the substantive requirements of these regulations will be met.

The Delaware Water Quality Standards set forth water quality standards for waters of the State. The standards are based upon water uses that are to be protected and are considered by DNREC in its regulation of discharges to surface waters. These would be applicable to point or non-point discharges from the site or recovered groundwater treatment discharges to the surface water.

The water quality standards are considered relevant to the site and will be complied with as part of meeting the substantive requirements of the NPDES permit process for treatment systems discharges.

The Delaware Stormwater and Sediment Regulations establish a statewide stormwater and sediment management plan. The requirements of these regulations are applicable to the Interim Groundwater Remedy because it is anticipated that over 5,000 square feet of land will be disturbed (e.g., clearing, grading, excavation, etc.) during site preparation and construction activities. To ensure compliance with this program, a site wide stormwater and sediment management plan will be submitted to DNREC and put in place prior to the start of construction related to the Interim Groundwater Remedy.

A Memorandum of Agreement between DRBC and EPA III (October 23, 1991) establishes standards for discharges to surface water and withdrawals from aquifers in the Delaware River Basin. Under this MOA, the DRBC does not review or require permits for groundwater withdrawal or recharge for federal Superfund sites in EPA Region III. However, the MOA does require that groundwater withdrawal meet the following four ARARs taken from the DRBC Groundwater Protected Area Regulations:

- Extraction wells must have readily accessible capped ports and drop pipes so that water levels may be measured under all conditions – All extraction wells will be appropriately equipped.
- Extraction wells shall be metered with an automatic continuous recording device that measures flow within 5% of actual flow – A daily record shall be maintained and annual withdrawal totals shall be reported to DRBC.
- Extraction wells shall not significantly interfere with domestic or other existing

wells – Based on the projected withdrawal rates of the extraction wells and the location of the site relative to other existing production wells, no significant impact on the flows of surrounding wells is expected.

- The operation of extraction wells shall not cause long-term progressive lowering of groundwater levels, permanent loss of storage capacity or substantial impact on low flows of perennial streams. The MOA establishes standards for discharges to surface water and withdrawals from aquifers in the Basin – Although the extraction system is designed to lower groundwater levels within the containment barrier wall, it will not significantly impact the storage capacity of the surrounding aquifer. Similarly, it is not expected that the reduction in groundwater flow to the Red Lion Creek caused by the remedy will significantly impact the creek's flow. With respect to the discharge standards cited, the treatment system has been designed to meet all applicable water quality standards including those of the DRBC.

Resource Conservation and Recovery Act (RCRA), as amended RCRA 42 USC §§6901 et seq, deals with the treatment and disposal methods of all hazardous wastes. Because DNAPL wastes and – at least initially – the extracted groundwater recovered from the site are expected to be hazardous and will be treated as hazardous wastes. In addition, it is possible that the spent carbon from the liquid-phase and vapor-phase carbon adsorption vessels will also be considered hazardous. For these reasons RCRA and the associated regulations under the DRGHW will be considered applicable to the SCD Site. Consequently, all hazardous wastes will be handled in accordance with the Federal hazardous waste regulations (40CFR §§261, 262.10-.58, 263, 264.170-.178, 264.1030-.1037, 268, and 270) promulgated under RCRA and/or the corresponding regulations under the DRGHW. Representative samples of spent carbon will be analyzed to determine whether the spent carbon will need to be treated as a hazardous waste. Until such a determination is made, the spent carbon will be handled as hazardous waste.

The Delaware Regulations Governing Solid Waste establish regulations for the development of a solid waste management program. Solid waste generated as part of the construction and operation of the Interim Groundwater Remedy will be handled in accordance with these regulations.

The Occupational Health and Safety Act (OSHA) (29 CFR Parts 1904, 1910, and 1926) provides occupational safety and health requirements applicable to workers engaged in onsite field activities. The regulations are applicable to onsite work performed during implementation of remedial actions. A Site Health and Safety Plan (HASP) has been written for all RD field activities at the SCD Site in accordance with OSHA occupational and health requirements. A separate HASP for Remedial Action activities will be prepared for construction phase services.

The Delaware Regulations Governing the Control of Air Pollution describe permitting requirements for air strippers that emit more than 2.5 pounds per day of pollutants. Because it is anticipated that emissions from the treatment system's air stripper will be greater than this level, these regulations are applicable to the Interim Groundwater Remedy. Consequently, the substantive requirements of these regulations will be met and vapor phase carbon will be used to treat the air stripper off-gas before discharge to the atmosphere. The selected remedy will be designed so that any air emissions from the treatment process will be in accordance with these regulations.

5.1.4 ARARs To Be Considered

The following are ARARs have been considered for the SCD Site:

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) (40 CFR Part 141). MCLs are enforceable standards for contaminants in public drinking water supply systems. They consider not only health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. The EPA has also proposed Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are non-enforceable guidelines that do not consider the technical feasibility of contaminant removal. Secondary MCLs (40 CFR Part 143) are intended as guidelines to protect the public welfare. Contaminants covered are those that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearances, and those that may limit public acceptance of drinking water provided by public water systems. The state of Delaware has adopted the MCLs under Section 22.60 of the Delaware Regulations Governing Public Drinking Water Systems.

The proposed treatment system design will not discharge treated groundwater to any public drinking water supply source although DNREC lists potable water source as a goal for the Red Lion Creek. Although the Columbia Aquifer from which the contaminated groundwater is being withdrawn is not currently being used as a public drinking water supply in the immediate area surrounding the SCD Site, it is classified as a Class II B aquifer (under the Groundwater Protection Strategy of 1984) because of its potential to be used as a drinking water source. In addition, it is apparent that at least one private well is screened in the Columbia Aquifer within one mile of the SCD Site. Although the ROD does not specify cleanup levels for the groundwater, the MCLs for the contaminants of concern at the site might be used in the determination of future cleanup levels. Consequently, the MCLs could possibly be considered relevant and appropriate in the future.

The Delaware Comprehensive Water Resources Management Committee Reports will be considered in developing the groundwater monitoring strategy for evaluating the effectiveness of the Interim Groundwater Remedy.

Because the ROD does not specify cleanup limits for the Interim Groundwater Remedy, neither the Health Effects Assessment nor the EPA Health Advisories – which deal with risk based criteria and the setting of cleanup standards for the protection of human life – will not be considered at this time.

OSWER Directive #9355.0-28, Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites. Air emissions from this Superfund Site shall be controlled through the use of carbon adsorption.

The Delaware Executive Order 56 on Freshwater Wetlands and the Governor's Roundtable Report on Freshwater Wetlands will be considered because of anticipated changes in wetlands hydrology that will result from implementation of the Interim Groundwater Remedy. No construction activities are expected to extend onto the wetlands surrounding the Red Lion Creek and its unnamed tributary.

5.2 Design Assumptions

During preparation of this design, assumptions have been made regarding the sequence of work; work by others; property access; treatment system performance; and available information at each location of interest. A description of each of the relevant assumptions is presented below, including (where applicable) a justification or supporting documentation regarding why BVSPC believes the assumption is accurate and acceptable.

- USEPA will obtain any necessary access agreements for constructing the extraction wells, containment barrier wall, and accessing the discharge piping/point from individual property owners in the general locations shown on the drawings included in Appendix E of this document.

- The estimated influent parameters described in Section 4.5 are assumed to be typical of the groundwater that will be encountered for the extraction well to be constructed during the RA. Because plant operations have ceased, it is not expected that additional sources of site-related contaminants will be introduced into the groundwater. Also, historical data has shown little change in the extent of the groundwater contaminant plume since the RI was performed.
- Assumed extraction rates can be obtained. This assumes that suitable water bearing features will be encountered during extraction well construction. If extraction rates cannot be achieved, construction of additional extraction wells might be required. Columbia Aquifer groundwater levels have been fairly well mapped across the potential extraction area. In addition, data from recovery wells operated at the SCD Site and on nearby properties indicate that the assumed extraction rates can be achieved.
- Cost-effective water treatment technologies that are capable of achieving the reductions in site-related contaminants necessary to meet NPDES permit limits are readily available.
- Cost-effective off-gas treatment technologies that are capable of achieving the reductions in site-related contaminants necessary to meet any State-imposed air emissions permit limits are readily available.
- The low permeability layer separating the Columbia and Upper Potomac aquifers acts to substantially limit hydraulic connection between the aquifers across the SCD site. Based on the results of recent sampling events, it appears that some site-related contamination has migrated from the Columbia into the Potomac aquifer. Geotechnical investigations conducted as part of the RD indicate that this clay layer is not continuous in the area to the north of the northern extent of the proposed barrier wall alignment.
- The low permeability layer separating the Columbia and Upper Potomac aquifers is thick enough in the proposed containment barrier wall construction area to allow successful keying of the barrier wall into it.
- In-situ chemical oxidation or the addition of extraction wells to the north of the barrier wall's proposed northern extent will be able to cost-effectively treat/control site-related contaminants remaining outside the northern extent of the containment barrier wall.

- Construction is scheduled to commence in late Fall 2005.

5.3 Process Flow Diagrams

The process flow diagrams provide a schematic of the treatment system that is anticipated for all locations of interest. As the design is developed further, some modifications may be made to the general process flow diagram and piping and instrumentation diagrams included with the Final Design Drawings in Appendix E of this document.

5.4 Operation and Maintenance Provisions

Minimum requirements for O&M activities and reporting by the RA subcontractor have been incorporated into the RA Plans and Specifications. The RA subcontractor will be required to submit for approval a Final O&M Plan providing a schedule and description of activities to monitor and maintain the integrity of the remedial activities.

The plan will include system inspection and repair, routine maintenance of mechanical equipment, site inspection and security, erosion and sedimentation control, and site vegetation. Additionally, a Health and Safety Plan (HASP) will be developed for all O&M activities.

5.5 Permitting

Although the ROD states that various permits will not be required for this Remedial Action, the design assumes that the permits shown in Table 5-1 (or permit equivalences) will be obtained to install, start up, and operate the Interim Groundwater Remedy.

6.0 Project Delivery Strategy

In the approved Remedial Design Work Plan dated September 13, 2002, a sub-task was included to determine the subcontracts, subcontracting procedures, and milestone schedule of required subcontracts to be prepared in the RD for implementation in the RA.

Developing a subcontracting strategy for a remedial construction project typically considers the structure of the project, how the various aspects of the project are related, whether any portion of the project requires capabilities unique to one type of contractor, the projected schedules of each component, and the potential impact that each component will have on the others. In addition, the interim groundwater remedy includes two major aspects (i.e., barrier wall and groundwater extraction/treatment system) that typically require very different construction skill sets. Consequently, there are a number of variables that have impacted decisions on contracting strategy for the construction portion of this project.

The soil/sediment remedy – if implemented as currently specified in the ROD and envisioned in the Soil/Sediment Design Comparison Study (BVSPC, 2003) – would require the installation of containment feature around (and excavation of) the contaminated areas of the tributary wetlands. Because there would be considerable overlap between the skills needed to accomplish these activities and those needed to construct the barrier wall portion of the groundwater remedy, it would likely be more cost-effective to combine these two activities under one construction subcontract. Additionally, combining these activities under a single subcontract would ease the coordination of two substantial construction activities occurring in close proximity. Further supporting this approach is the potential to use the western arm of the groundwater containment barrier wall as the eastern wall of the wetlands containment feature. However, because of higher than anticipated projected costs for the excavation and treatment of the contaminated wetlands materials, EPA and DNREC are currently investigating the potential for using another, less intrusive, method (in-situ chemical oxidation) for treating the wetlands materials. Consequently, schedule differences between the groundwater and soil/sediment portions of the remedial action have made it apparent that combining these projects under a single subcontract will not be possible.

In a similar regard, while combining the construction of the barrier wall with the construction of the groundwater extraction/treatment system would ease coordination of activities, the skills required for each of the two activities do not have substantial overlap. Consequently, if a single subcontract is executed to cover both activities, it is likely that the selected subcontractor would employ a second tier subcontractor to complete the portion of the construction that does not fall within their specialty. This could result in increased costs (in the form of pass-through charges) in some areas of the project. Furthermore, because of the highly specialized skill set that is required for the construction of the barrier wall, it is possible that there would be insufficient competition if the project were restricted to small businesses. Therefore separate subcontracts will be utilized for the extraction/treatment system construction and barrier wall construction efforts. The barrier construction subcontract will be competed without size restrictions while the extraction/treatment system subcontract being competed as a small business set-aside. This will allow for increased participation of small and small disadvantaged businesses in the bidding process without seriously impacting the quality of the RA construction activities. To help with this approach, portions of the design have been treated as two separate subprojects.

Construction activities under these subprojects will be coordinated to ensure that the various construction activities can be carried simultaneously without negatively impacting each other. Site work will commence with the relocation and installation of utilities, abandonment of certain wells, demolition of structures, and relocation of the soil piles. New monitor wells and piezometers will then be installed in those locations that will not interfere with other construction activities. Decisions as to the sequence of barrier construction will be made in cooperation with the selected RA contractor, but it is expected that the northern end of the barrier will be completed last to minimize mounding of contaminated groundwater within the barrier. During barrier construction activities, the work platform installation will precede barrier trenching and backfilling. The remaining piezometers and monitor wells will be constructed periodically as each leg of the barrier construction is completed. It is expected that construction of the groundwater extraction and treatment system will commence following the completion of the southern portions of the barrier. This will minimize construction conflicts but still allow for the completion of the treatment system prior to the completion of the containment barrier.

Start up and initial (shakeout) operation and maintenance options (approximately one to two years duration) will be included in each construction subcontract. Subsequent operation and maintenance activities will be further evaluated with EPA and DNREC. Start up testing requirements will focus on permit compliance and obtaining extraction rates to reverse/equalize the gradient between the Columbia and Potomac aquifers. The schedule for preparation of the subcontract will follow the schedule included in the approved WA and any subsequent modifications. An updated RA Construction Schedule is included in Section 9.

Permit compliance for the site will be determined in discussions with EPA, DNREC, and DRBC officials. The Interim Groundwater Remedy – as proposed – will meet the substantive requirements of all ARARs. Current estimates of the required compliance activities are based on the calculations using local, Delaware and federal regulations, as well as the former SCD facility's most recent NPDES and air emissions permits. Included in the expected compliance requirements will be regular sampling of the treatment system's air emissions and treated water discharge, determining water levels in Columbia and Potomac screened monitor wells, water quality sampling/analysis of Columbia and Potomac screened monitor wells, water quality sampling/analysis of Red Lion Creek surface water and sediments, and sampling of the system's influent and intermediate (i.e., within the treatment train) water quality. The subcontract being prepared under this WA, WA No. 038-RDRD-03H6, will include start-up compliance requirements.

Containment of the majority of the contaminant plume is to be achieved by construction of the containment barrier wall that encircles the majority of the SCD Site. As mentioned earlier, additional measures, such as added extraction wells located outside the barrier wall, extension of the barrier wall to encircle additional areas, or injection of chemical oxidants to achieve in-situ source treatment, could be included as part of the Final Groundwater Remedy if it is determined that contaminated materials remaining outside the barrier wall continue to act as sources for groundwater contamination. Measurement of containment is anticipated to be a long term, ongoing effort. Ongoing measurement of plume containment will be used to evaluate the efficacy of the remedy as implemented. The long term containment objectives will be considered but not be incorporated as a subcontractor requirement in the initial start up and operations and maintenance of the systems under this WA.

Similarly, long term monitoring of contamination is part of the overall containment objective for the site. Discharge compliance sampling and groundwater contaminant monitoring sampling will be conducted by BVSPC with the assistance of the Subcontractor. Typically this would indicate that sample analyses would be performed by an EPA CLP laboratory, but the need for short turnaround times might necessitate the use of a local non-CLP lab for certain analyses. A final decision on laboratory services will be made following future discussions with EPA and DNREC. Thus, the need for CLP or subcontracted laboratories, as well as the need for other long term service subcontracts are yet to be determined under WA No. 038-RDRD-03H6. Some of these requirements would be beyond the scope of the initial remedial action subcontracts, but will be further identified as the design progresses under this WA. Telephone, electrical and water services will be arranged through local utility providers and paid on a monthly or quarterly basis as per utility requirements.

For the remedial construction subcontracts, both performance-based specifications and means and methods specifications have been used. A performance specification is included for the extraction and treatment process as a feature of the project delivery strategy. Indications from the environmental services industry are that several available treatment systems can achieve the groundwater contamination reduction anticipated to be required under the NPDES in conjunction with the pumping rates needed to meet the ROD objectives. To ensure a competitive bidding situation with lower costs to the government, extraction and treatment performance specifications, rather than prescriptive specifications were used to allow bidding, construction, and operation of various treatment systems that follow a basic format.

Performance specifications require three elements: requirement, criterion, and test. The requirement is a qualitative statement of desired performance. The criterion is a quantitative statement of desired performance. The test is an evaluative procedure to ensure compliance with the criteria. Performance specifications are used to describe attributes of a system such as serviceability, durability, safety, and the environment. Thus, the design development focused on these attributes and elements for pumping and treatment in the specifications.

A fixed price with unit price adjustment format will be used for the initial construction subcontracts. Follow-on start up and operations & maintenance under the contract will be primarily fixed price with performance fee, but certain items will be paid on a cost reimbursable or time and materials basis. Two-step bidding is expected for the construction. Performance and payment bonding will be required for the subcontract.

Measurement and payment items have been structured to allow flexibility in adjusting the constructed remedial system as a component of the project delivery schedule. During construction and testing, the number of wells, well sizes, locations, etc. may require adjustment for optimal remediation performance. Fixed unit adjustment prices will be incorporated into the Final Subcontract Documents to allow for adjustments by the remediation subcontractor with the approval or at the direction of BVSPC and EPA Region III.

The project delivery strategy will be in accordance with the Prime Contract, the Prime Contract Small Business Utilization Goals, and the appropriate FAR clauses. A feature of the project delivery strategy is to prepare the Final Subcontract Documents for subsequent bidding and award to a Small Business Enterprises (SBE). This will be accomplished by either pre-qualifying only SBE firms as potential subcontractors, or by giving preference to SBE firms in their bid evaluation. Because of the anticipated cost and specific technical expertise required for the barrier wall construction subcontract, the subcontract, a preferential evaluation system will be developed for SBEs that are prequalified for and submit bids for that subcontract. This preference may be in the form of a 10% price differential or a weighted evaluation process that assigns higher points to SBEs as part of an overall evaluation process. Conversely, there are multiple small business firms that are capable of performing the anticipated extraction/treatment system construction work, and small business utilization is a prime contract goal and overall agency goal of EPA. Therefore, as mentioned earlier, this subcontract will be issued as a small business set aside.

The ROD for the site refers to a long-term groundwater monitoring program being in compliance with an EPA and DNREC approved O&M Plan. Such a plan would be for the overall site and might include provisions for the O&M of the Final Soil/Sediment Remedy as well as this Interim Groundwater Remedy. The responsibility for preparation of the overall site O&M Plan is to be determined. However, this WA assumes that BVSPC (or its subcontractor) will prepare an initial O&M Manual for the equipment and facilities installed under the RA subcontract.

In preparing the O&M Manual specifications, consideration will be given to structuring options within the Final Contract Documents to allow the RA contractor limited or extended O&M of the system after start up and shake down. BVSPC will consider the most cost effective method of completing the O&M for the government. O&M contracting methods included in the final RA Subcontracts will be consistent with requirements outlined in the U.S. Environmental Protection Agency (EPA) document *Consideration for Preparation of Operation and Maintenance Manuals* (EPA 430/9-74-001).

7.0 Final Design Drawings

Final Design Drawings are included in Appendix E. As part of this Final Design submission, the following sheets have been developed in accordance with the work plan:

Subproject I: Groundwater Extraction & Treatment System Design

- GG-0 Title Sheet
- C1-1 Vicinity Map, Legend, Abbreviations
- C1-2 Extraction/Treatment System Plan View
- C1-2A Treatment Building Grading Plan
- C1-3 Piping/Well Profile I
- C1-4 Piping/Well Profile II
- C1-5 Piping/Well Profile III
- C1-6 Well Details
- C1-7 Miscellaneous Details
- GP-1 Instrumentation Legend And Abbreviations
- GP-2 General Process Flow Diagram
- GP-3 Treatment System P & ID
- GP-4 Treatment System P & ID
- GP-5 Treatment System P & ID
- GP-6 Treatment System P & ID
- AS-1 Architectural And Structural Building Plan
- ME-1 Mechanical And Electrical Building Plan
- C2-9 Erosion & Sedimentation Control Plan
- C2-17A Erosion & Sedimentation Control Details
- C2-17B Erosion & Sedimentation Control Details

Subproject II: Barrier Wall Design

- C2-1 Title Sheet
- C2-2 Vicinity Map & Legend
- C2-3 Existing Conditions
- C2-4 Demolition & Utility Abandonment
- C2-5 Boring Plan
- C2-6 Barrier Alignment Plan
- C2-7 Proposed Wells & Abandonment Plan
- C2-8 Interim Grading Plan
- C2-8A Interim Grade SE Quadrant
- C2-8B Interim Grade NE Quadrant
- C2-8C Interim Grade SW Quadrant
- C2-8D Interim Grade NW Quadrant

- C2-9 Erosion & Sediment Control Plan
- C2-10 Barrier Section I
- C2-11 Barrier Section II
- C2-12 Barrier Section III
- C2-13 Barrier Section IV
- C2-14 Barrier Section V
- C2-15 Barrier Section VI
- C2-16 Barrier Section VII
- C2-17A Erosion & Sedimentation Details
- C2-17B Erosion & Sedimentation Details
- C2-18 Barrier Wall Details
- C2-19 Miscellaneous Details
- C2-20 Barrier Platform Profiles
- C2-21 Barrier Platform Profiles
- C2-22 Interim Remedy Final Site Conditions

8.0 Specifications

The technical specifications to be used for Remedial Action construction activities are listed below and presented in Appendix F.

DIVISION 1 - GENERAL REQUIREMENTS

Section 01015 Project Requirements
Section 01025 Measurement and Payment
Section 01070 Abbreviations
Section 01300 Submittals
Section 01400 Quality Control
Section 01500 Temporary Facilities
Section 01605 Sampling for Chemical Testing
Section 01606 Materials Handling and Disposal
Section 01610 General Equipment Stipulations

DIVISION 2 – SITEWORK

Section 02050 Demolition and Salvage
Section 02080 Asbestos Abatement
Section 02090 Lead Based Paint Abatement and Demolition
Section 02150 Wells
Section 02200 Earthwork
Section 02202 Trenching and Backfilling
Section 02223 On-Site Staging and Stabilization of Contaminated Soils
Section 02270 Erosion & Sediment Control
Section 02395 Hydraulic Barrier
Section 02396 Laboratory Testing of Hydraulic Barrier Backfill
Section 02512 Asphalt Concrete Paving
Section 02600 Existing Utilities
Section 02605 Sewer Manholes
Section 02606 Iron Manhole and Vault Covers and Accessories
Section 02630 Polyvinyl Chloride (PVC) Pressure Pipe
Section 02704 Pipeline Pressure and Leakage Testing
Section 02832 Chain Link Fence
Section 02930 Seeding and Sodding
Section 02950 Trees, Shrubs and Ground Cover

DIVISION 3 - CONCRETE

Section 03301 Cast-in-Place Concrete
Section 03411 Precast Concrete

Section 03600 Grout

DIVISION 4 – MASONRY (Not used)

DIVISION 5 – METALS (Not used)

DIVISION 6 – WOOD AND PLASTIC (Not used)

DIVISION 7 – THERMAL AND MOISTURE PROTECTION (Not used)

DIVISION 8 – DOORS AND WINDOWS (Not used)

DIVISION 9 – FINISHES (Not used)

DIVISION 10 – SPECIALTIES (Not used)

DIVISION 11 – EQUIPMENT
Section 11180 Sump Pumps
Section 11210 Submersible Well Pumps
Section 11211 Centrifugal Pumps
Section 11430 Groundwater Treatment System - Performance Specifications
Section 11710 System Monitoring and Cleanup Verification

DIVISION 12 – FURNISHINGS (Not used)

DIVISION 13 - SPECIAL CONSTRUCTION
Section 13120 Pre-Engineered Structure

DIVISION 14 – CONVEYING SYSTEMS (Not used)

DIVISION 15 – MECHANICAL
Section 15060 Miscellaneous Piping
Section 15100 Miscellaneous Valves
Section 15140 Pipe Supports
Section 15400 Plumbing
Section 15500 Heating and Ventilating

DIVISION 16 – ELECTRICAL
Section 16050 Electrical
Section 16670 Lightning Protection System
Section 16721 Fire Detection and Alarm
Section 16901 Control System

9.0 Projected Remedial Action Schedule

An updated RA construction schedule is presented in Appendix J. The entire duration of the remedial action is approximately 29 months, which includes bidding, an approximate nine-month construction duration, an additional three-month startup, testing and prove out period, and one year of initial "shakedown" O&M. The schedule is based on the RA Request for Proposal (RFP) being issued on November 30, 2005.

The schedule assumes that the subcontractor(s) will construct the treatment system during the latter stages of the containment barrier construction. Therefore, the construction period may be adjusted to allow for revised construction approach.

10.0 Final Cost Estimate

The following cost figures summarize the updated Remedial Action cost estimate contained in Appendix K of this Final Remedial Design Report. This updated RA cost estimate was developed using M-CACES for Windows Release 1.2C. It shows the current interim cost estimate for Remedial Action to be $7,206,797.

Note that there is an O&M line item in the cost estimate. This line item actually represents the estimated cost of operating and maintaining the system during the one-year "shakedown" period prior to the system being certified as “Operational and Functional” by EPA. Thus, this is not O&M as defined by EPA, but rather the last part of the Remedial Action. O&M as defined by EPA begins only after the remedy is determined by EPA to be operational and functional.

EPA expects that the first three years (the shakedown year plus the first two years of O&M) will have higher system operation costs, approximately $853,000 per year. This is due to the need to pump groundwater at a higher rate (approximately 43 gpm) to lower the ground water level within the barrier wall and achieve a neutral or slightly negative hydrostatic pressure head difference (vertical gradient) relative to the underlying Potomac Aquifer.

After approximately three years of pumping at the higher rate, EPA expects to be able to lower the pumping rate to approximately 18 to 24 gpm and maintain the desired vertical gradient at an annual O&M cost of about $525,000. This assumes that influent characteristics remain the same, but the volume of water requiring treatment is reduced by about 50% to 60%. Furthermore, this cost reduction assumes that analytical costs, labor costs, and utility costs will decrease by 30% once the reduced flow treatment and discharge levels are stabilized. When the flow rate is reduced, certain process pumps and possibly extraction well pumps might have to be replaced (resulting in capital costs that have not been included in the O&M figure).

Conversely, if it is determined that additional pumping is required from outside the barrier wall (for a total extraction rate of 70 to 95 gpm) to address contamination located to the north of the barrier, it is expected that the annual operating expense would be in the range of $900,000 to $1,050,000. For this higher extraction rate, carbon and chemical usage would increase, and it is assumed that once the discharge levels are stabilized utilities would increase by 30% over the baseline figure while analytical costs and labor costs would decrease by 30%.

Please note that all of these estimates include an assumed profit rate, bonding, and a contingency of 20% as per M-CACES standards. Costs for oversight by the Remedial Action Contract (RAC) contractor are not included in this cost estimate but would be determined and negotiated as part of the RA.

11.0 References

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TABLES

FIGURES